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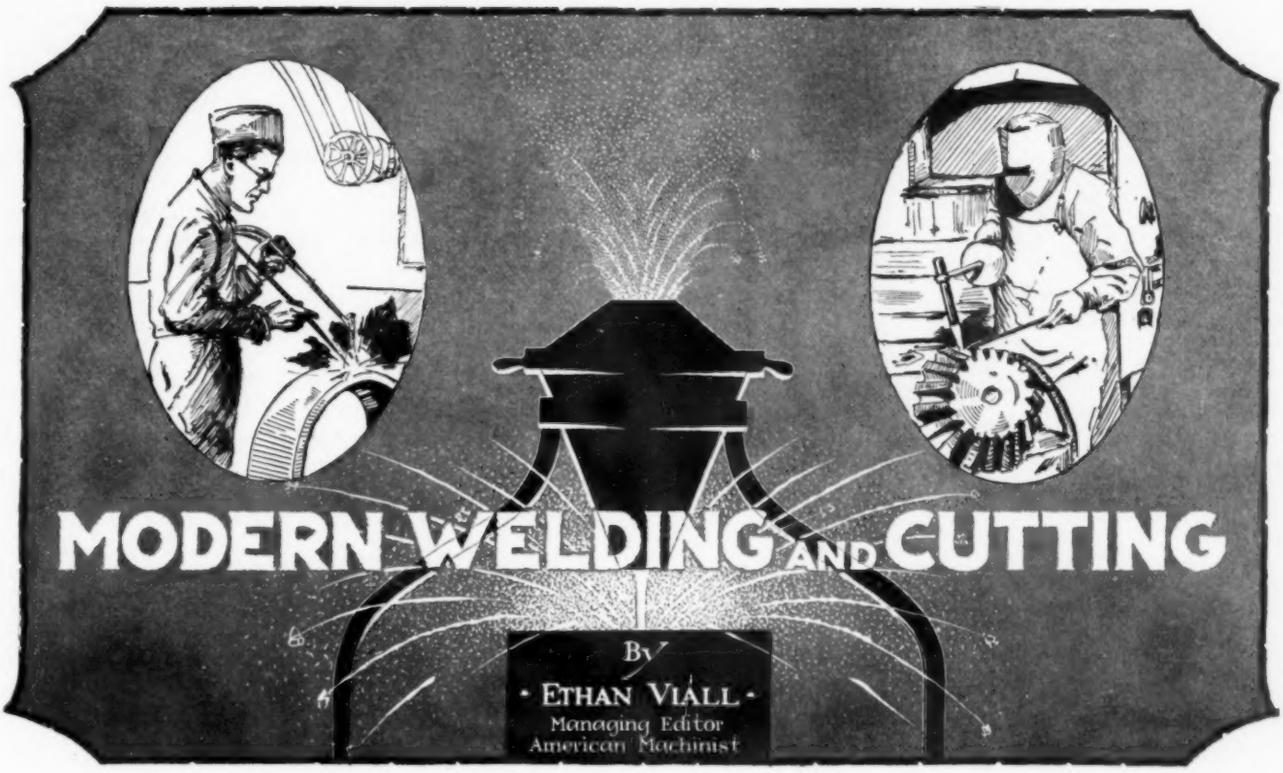
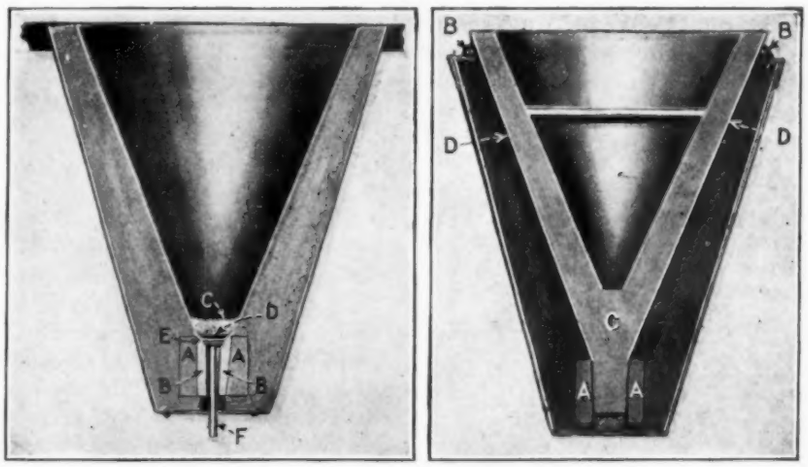


II. Fusion Welding of Heavy Sections With Thermit*

The welding of heavy sections with Thermit is an entirely different proposition from that of welding pipe. This article clearly shows the difference in methods and apparatus used.

THE method of welding heavy sections and castings, or the fusion method, differs considerably from that used for welding pipe joints. For one thing the parts to be welded must be preheated to a red heat and also another type of crucible is needed. The type of crucible used is shown in Fig. 7. This is a conical-shaped, sheet-metal receptacle, or shell, with an opening in the lower pointed end. In use this is suspended or supported above the gate of the mold by means of a tripod, bracket or other support. The metal receptacle is lined with magnesia tar, a hard-burnt magnesia stone being set in as shown at *A*. This has a tubular opening in it into which a small magnesia thimble *B* is pressed. This thimble provides a channel through which the liquid Thermit steel is poured into the mold. The object of making the crucible so that it may be tapped from the bottom is to prevent the slag from entering the mold, which is directly opposite to the procedure for welding pipe. The hole in the bottom of the crucible is closed previous to putting in the Thermit mixture by means of the tapping pin *F*, the asbestos washer *E*, the metal disk *D* and the refractory sand *C*. This sand is put up in small bags for the purpose by the company selling the mixture. When everything is ready the Thermit is put into the crucible and ignited exactly as described for pipe welding. After the reaction the tapping pin is pushed up as shown in Fig. 8 and the molten steel allowed to run out into the mold.



FIGS. 7 AND 9. SECTIONAL VIEW OF THERMIT AUTOMATIC CRUCIBLE AND METHOD OF LINING IT

Fig. 7—AA, magnesia stone; BB, magnesia thimble; C, refractory sand; D, metal disk; E, asbestos washer; F, tapping pin. Fig. 9—Method of lining a crucible—AA, magnesia stone; BB, luting of fire clay; C, cast iron crucible cone; D, layer of wrapping paper or newspaper.

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The crucible and the thimble through which the metal runs after the reaction are two of the most important factors in the whole process. The high temperature,

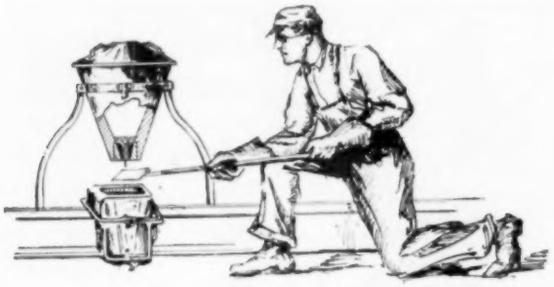


FIG. 8. TAPPING A CRUCIBLE

together with the violent ebullition of the molten metal during the reaction, necessitates a lining that is not only mechanically strong but of a very high refractory substance. It has been found that magnesia-lined crucibles are the only ones that satisfy these conditions.

Life of Lining Prolonged by Patching With Magnesia Tar

As refractory as this material is, however, the crucibles that are used to any extent must be relined. Sometimes the life of a lining may be prolonged by patching with magnesia tar where needed and then baking it. While any good mechanic can scheme out ways to line a crucible in an emergency and may use fire clay on occasion the following method is given as the best way:

The magnesia-tar lining material should be heated until it becomes plastic. A few handfuls are then placed in the bottom of the crucible shell and a magnesia stone imbedded in this material, as shown in Fig. 9, and centered over the hole. More magnesia tar is then rammed around the stone to hold it firmly in place. The cast-iron crucible cone should then be placed in position with the small projection set into the hole in the magnesia stone. The upper part is next centered in the shell by means of wedges inserted at equal distances along the circumference. The magnesia tar is then

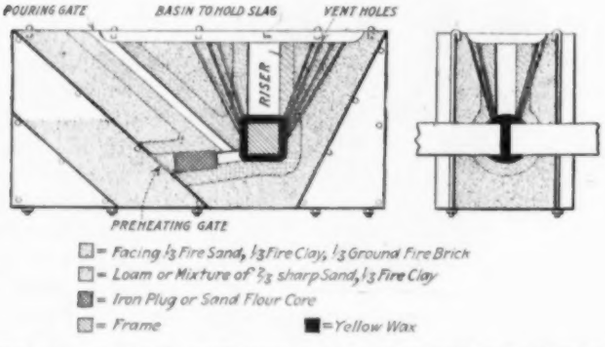

POURING GATE
BASIN TO HOLD SLAG
VENT HOLES
RISER
PREHEATING GATE
= Facing 1/3 Fire Sand, 1/3 Fire Clay, 1/3 Ground Fire Brick
= Loam or Mixture of 2/3 sharp Sand, 1/3 Fire Clay
= Iron Plug or Sand Flour Core
= Frame
= Yellow Wax

FIG. 10. TYPICAL THERMIT MOLD FOR HEAVY SECTIONS

rammed into the space between the cone and the shell a little at a time and tamped hard. On the density or hardness of the lining depends the life of the crucible. Special iron tamping tools with flat ends should be used. The rammer should be pounded well with a good-sized hammer when ramming in the lining. Better still is a pneumatic bench rammer.

Do not put in the material too rapidly, and let it be remembered that the better and more uniform the tamping the longer the crucible will last.

As the mass nears the top the wooden wedges should be removed as the lining already in place will hold the cone in position.

The Crucible Ready for Baking

When completely filled and tamped a mark should be made with a piece of chalk on the cone and the point opposite to it on the lining, so that when the cone is withdrawn it may be replaced exactly as before. Then take the cone out, exercising care not to disturb the lining, place a layer of wrapping paper or newspaper over the tar lining, then replace the cone carefully, so that the marks previously made come opposite to each other. After this put on the crucible ring and lute carefully around the top with fire clay to protect the upper part of the lining from the heat in baking. It is also well to place damp fire clay around the bottom

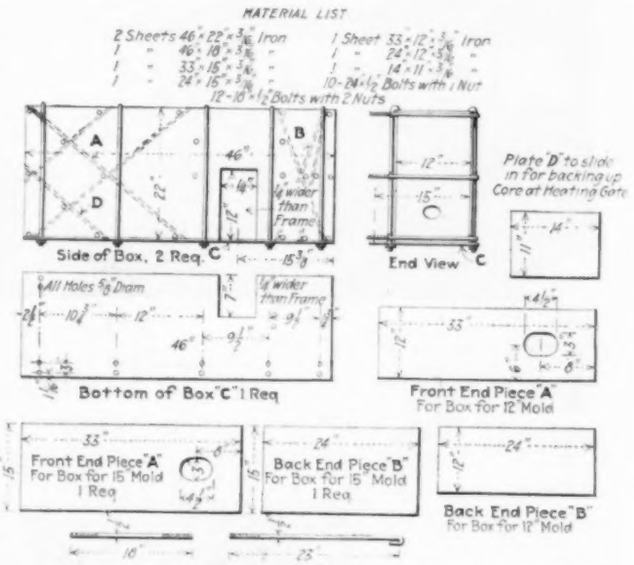

MATERIAL LIST
2 Sheets 46" x 22" x 3/16" Iron
1 " 46" x 18" x 3/16" "
1 " 33" x 15" x 3/16" "
1 " 24" x 15" x 3/16" "
1 Sheet 33" x 12" x 3/16" Iron
1 " 24" x 12" x 3/16" "
1 " 14" x 11" x 3/16" "
10-24" x 1/2" Bolts with 1 Nut
12-16" x 1/2" Bolts with 2 Nuts
A
B
D
C
Side of Box, 2 Req.
End View
Plate "D" to slide in for backing up Core at Heating Gate
All Holes 5/8" Diam
1/4" wider than Frame
Bottom of Box "C" 1 Req
Front End Piece "A" For Box for 12" Mold
Front End Piece "A" For Box for 15" Mold 1 Req
Back End Piece "B" For Box for 15" Mold 1 Req
Back End Piece "B" For Box for 12" Mold

FIG. 11. DESIGN AND MATERIALS REQUIRED FOR STANDARD MOLD BOX

of the crucible and inside of the stone for the same purpose.

The crucible is now ready for baking, and for this purpose it should be placed in a suitable oven. The heat should gradually be raised until the cast-iron cone becomes red hot and should be held at that temperature until all the fumes stop coming off from the tar, after which it can be allowed to cool gradually before removing from the oven. If the crucible is baked too long the lining will appear crumbly and the life of the crucible will be very much shortened. Baking for too short a time will leave some of the tar in the lining and cause a violent Thermit reaction. When cool the clay luting may be removed, the cone taken out and the crucible is ready for use.

Thimbles

The portion that has to withstand the most severe strain of all is the part at the bottom of the crucible, or walls of the hole through which the metal is tapped. It has to stand the wash and pressure of the weight of the moving liquid metal and slag under great heat.

The magnesia stone which is centered in the bottom of the crucible and around which the material for lining is packed has a tapered hole in the center. The thimbles are of the same taper as the hole in the magnesia stone and are set into the latter. When the thimble is used up (either through enlargement of hole or by splitting) it can be knocked out and replaced with a new one, so that the full life of the crucible may be utilized. Thimbles should be wrapped with one layer of uncreased paper before being placed in position.

Since various amounts of Thermit must be used for different sized welds the crucibles used must vary accordingly, although it is possible on occasion to use more than one crucible at a time for a given melt. This is not advisable, however, unless necessary. For lining these various sized crucibles the Thermit company makes magnesia stones and thimbles in certain sizes designated by numbers. The metal cones as well as crucibles of a given capacity are also numbered. All of the ordinary sizes, as well as the amount of magnesia tar needed, are shown in Table III.

TABLE III. DETAILS OF AUTOMATIC CRUCIBLES, LINING MATERIALS, CONES, STONES AND THIMBLES

Size of Crucible	Capacity in Pounds of R. R. Thermit	Gross Shipping Weight of Crucibles Pounds	Outside Diameter at Top, Inches	Height, Inches	Size of Magnesia Stone for Relining	Size of Magnesia Thimble to be Used	Size of Plugging Material to be Used	Weight of Magnesia Tar Required for Relining, Pounds	Size of Crucible Cone Corresponding to Size of Crucible	Shipping Weight of Cones, Pounds
No. 1	6	40	8½	8½	No. 1	No. 1	No. 2	8	No. 1	50
No. 2	8	60	10	10	No. 1	No. 1	No. 2	20½	No. 2	50
No. 3	15	110	12½	13½	No. 2	No. 2	No. 2	42	No. 3	75
No. 4	25	125	14½	15	No. 2	No. 2	No. 2	61½	No. 4	125
No. 5	35	150	16½	15	No. 2	No. 2	No. 2	87	No. 5	150
No. 6	70	250	20	21	No. 2	No. 2	No. 2	141	No. 6	225
No. 7	140	450	25½	25	Nos. 1 and 2	No. 2	No. 2	216	No. 7	375
No. 8	210	525	28	28	Nos. 1 and 2	No. 2	No. 2	258	No. 8	375
No. 9	280	650	30½	29½	No. 3 and 3 Spec.	No. 3	No. 3	327	No. 9	600
No. 10	400	775	34	34	No. 3 and 3 Spec.	No. 3	No. 3	408	No. 10	600

NOTE.—Four magnesia thimbles and five packages of plugging material are supplied with each new crucible.

We have described in detail the construction of automatic crucibles to be used in connection with Thermit welding, and it might be well to include a few words on the proper care of these crucibles.

They should be very carefully handled, as the lining is apt to crack or fall out under rough treatment. It is also always important that they be stored in a dry place, as the lining, being porous, will absorb moisture, and a moist lining will cause violent Thermit reaction.

After a crucible has once been used, it is not necessary to clean it of the slag adhering to the inside, as this is a very refractory material itself and can do nothing but help preserve the crucible if left on. At the bottom, however, in the vicinity of the stone and thimble, the slag has to be removed so as to clear the opening of the thimble or permit of an old thimble being knocked out and a new thimble inserted.

With the construction and method of using the automatic crucible in mind we will next take up the welding of heavy or solid sections in detail. In order to make this clear a typical Thermit mold is shown in Fig. 10. With this illustration to refer to the following directions will be readily understood:

We will suppose that the parts to be welded are those of a broken frame. It is best to put tram marks on the two sections far enough back from the fracture to be outside the mold box when it is in place. These are convenient to measure from when allowing for the contraction of the Thermit steel as it cools. Next cut along the lines of the fracture so that an opening of from 1 to 1½ in. is provided. The amount of the opening depends on the size of the sections to be welded, but in no case should it be less than an inch. If it is a diagonal fracture it is usually best to cut it so as to make as near a vertical opening as possible.

There are various ways of cutting away the metal for the opening, such as sawing, drilling and chiseling, but the best way is to use an acetylene and oxygen cutting torch. In any case the opening should be clear enough to allow the free flow of the Thermit. Now clean the ends of the sections thoroughly for at least four inches from the opening, so as to expose the good, bright metal. Be sure to remove all dirt or grease as far back as the mold box will reach, so that when the mold is rammed up and heat applied there will be no grease to burn out and leave a space between the mold and part to be welded.

If the oxyacetylene torch is used for cutting be sure to remove all oxide or scale left on the parts by the operation. Next make allowance for contraction by setting the parts away from each other a sufficient amount to make up for the contraction of the Thermit steel and adjacent parts in cooling. This should be varied from ⅛ in. to ¼ in., depending on the size of the weld. In many cases it is necessary to obtain this increased space by

forcing the sections apart with a jack or other mechanical means. In other cases, such as the welding of a double-barred locomotive frame, it will be necessary to heat an opposite member by means of a flaming burner attachment on a double-burner preheater or by using a basket fire. It is sometimes advisable to construct a small fire-brick or sheet-iron furnace around such a section in order to confine the heat or

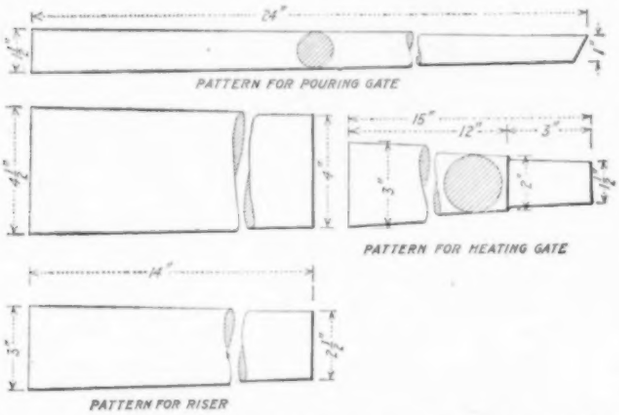


FIG. 12. WOODEN PATTERNS FOR POURING GATE, RISER AND HEATING GATE OF MOLD. THESE ARE LARGE ENOUGH FOR WELDS UP TO 5 x 7 IN. LARGER WELDS REQUIRE PROPORTIONATELY LARGER PATTERNS

protect other parts from the flame. This, however, is done only at the time of preheating.

With the parts lined up and proper allowance made for contraction they are ready for the wax mold.

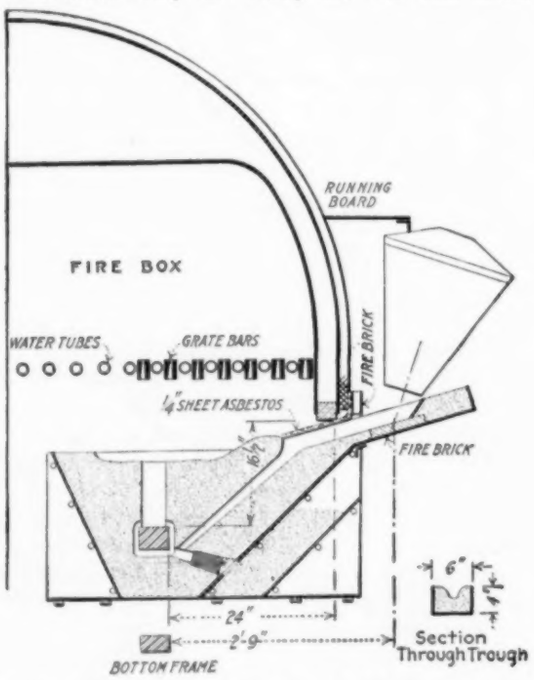


FIG. 13. METHOD EMPLOYED IN MAKING WELDS IN INACCESSIBLE PLACES

The wax-pattern molds are made of yellow wax, as indicated in the illustration of a typical mold. This wax is placed in a pan and warmed until it becomes plastic or else melted entirely and then allowed to cool until plastic. This wax is then shaped around the parts to be welded in the form of a collar as shown. The opening between the ends should also be filled with wax, and it is necessary to provide a vent hole through the wax extending from the location of the heating gate to the riser. The best way to do this is to imbed a piece of good stout twine in the wax, which can be pulled out after the pattern is formed.

The mold box, details of which are shown in Fig. 11, should then be placed in position and securely blocked up so that all weight will be removed from the sections to be welded.

We are now ready for the molding material. This should consist of one part fire clay, one part ground fire brick and one part fire sand. This is used for the facing of the mold or the part that comes in contact with the Thermit steel. If it cannot be obtained in the vicinity it can be ordered from the Thermit company. This material should be well riddled, mixed dry and then moistened with just enough water so that it will pack well.

In ramming up the mold place a small amount of molding material in the box and ram with a small ram-

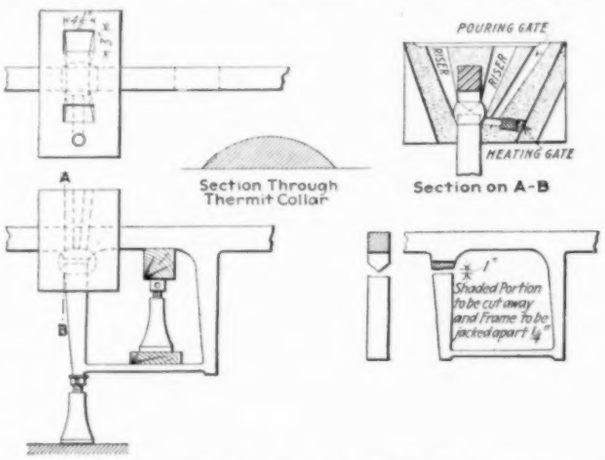


FIG. 15. METHOD EMPLOYED IN WELDING LOCOMOTIVE FRAME BROKEN IN LEG

mer around the edges and working toward the center, keeping the mold level, and *ram hard.* Too much emphasis cannot be laid on this point, for in the construction of the mold depends the safety of the entire welding operation. See to it that the material is well rammed underneath the pattern. There should be a wall of molding material at least 4 in. thick between the wax pattern and the mold box at all points, as the Thermit steel is intensely hot and ample material must be provided to hold it. A wooden gate pattern for the preheating opening should be set at the lowest point of the wax pattern and leading out to the front of the mold box, where an opening is provided for it. Where the sections to be welded together are of the same size this preheating gate should be set directly in the middle of the lowest part of the wax pattern so as to heat both sides of the frame equally. Sometimes, however, it is necessary to weld a light frame section to a heavier one, in which case the preheating opening should favor the heavier section, which will require a longer time to heat than the light section.

With the preheating gate provided for, set another wooden gate pattern directly above it and one inch away from the wax pattern and have it properly shaped for the pouring gate. Drawings for these various patterns are shown in Fig. 12.

Be sure that the molding material is well rammed around these patterns so that it will not "cut out" under the blast of the preheater.

At the highest point of the wax pattern place the riser pattern. If there is more than one high point, place a riser pattern over each, as the function of a riser is to hold a supply of steel which will remain liquid for a considerable period of time, and take care of all shrinkage, so that when a "pipe" is formed, due to shrinkage, this pipe will appear in the riser and not in the weld. Also the riser acts as a depository for loose sand or other foreign matter that may be washed into it by the Thermit steel in passing through the mold and prevents this material from clogging in the weld. It sometimes happens that welds are made at a point where a wooden riser pattern cannot be withdrawn conveniently. In such cases a piece of jacket-iron pipe may be used and left in the mold after ramming up. The Thermit steel will flow into this opening and simply melt the iron pipe and amalgamate with it.

After the mold is all rammed up, hollow out on top so as to form a basin in which the slag may collect so as not to overrun the mold box. Then vent the mold thoroughly by making holes with a vent rod made from 8 to 10 gage steel wire, so that all gases in the liquid metal will have a chance to escape, as shown in the typical mold. This is important.

Now lightly rap the gate, riser and preheating opening patterns and draw them out carefully, wiping away any loose sand that might tend to fall into the holes. A molder's slick, trowel and lifter are very useful in this connection. Then cover the various openings so that nothing will fall into them and adjust the crucible in position with the bottom about three inches above and directly over the center of the pouring gate. Where this cannot be done, construct a runner, as shown in Fig. 13, to lead the steel into the pouring gate of the mold.

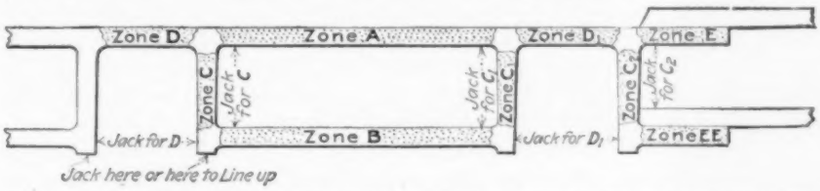


FIG. 14. METHOD OF PREVENTING UNEQUAL STRESSES WHEN WELDING LOCOMOTIVE FRAMES BROKEN AT VARIOUS POINTS

Fracture Location	Remarks
Zone A*	Heat zone B to get $\frac{3}{16}$ in. expansion and hold 2 to 3 hours after welding. Preheater or basket fire.*
Zone B*	Heat zone A to get $\frac{3}{16}$ in. expansion and hold 2 to 3 hours after welding. Preheater or basket fire.*
Zone C, C1 or C2	Jack $\frac{3}{16}$ in. at C, C1 or C2; keep jack in place 2 to 3 hours after welding and then remove entirely.
Zone D or D1	Jack $\frac{3}{16}$ in. at D or D1; keep jack in place 2 to 3 hours after welding and then remove entirely.
Zone E	Cut out unfractured member of splice to clear collar.

*When heating either Zone A or Zone B the adjacent pedestal brace or braces should be put in place before commencing to heat so as to distribute the expansion and not upset or distort the leg.

The mold is now ready for preheating. Set the burner of the preheater so as to point into the heating gate of the mold and about one inch from the opening; then apply the blast. It is best to start easily at first, as too much of a blast would tend to "cut" the mold. The wax will burn out, leaving a perfect mold the shape of the wax pattern. Keep the heat going until the mold is thoroughly dried out and the parts to be welded are brought up to a good, red, workable heat such as would be required if the frame was to be hammered.

While the preheating is in progress the charge of Thermit and additions should be placed in the crucible, which is first plugged in accordance with the directions previously given. It is important to put in a few handfuls of Thermit first before dumping in the rest of the charge, so as not to disturb the plugging material. Mix the Thermit charge thoroughly before putting in the crucible. No ignition powder should be added until the Thermit charge is ready to be ignited. If the Thermit charge when leveled off comes closer than 2 in. to the top of the crucible or if the crucible has to be tipped slightly it is best to build up the crucible by means of a ring. This ring should be less in diameter than top of crucible so it can set in the crucible about 1 in. It should be from 8 to 10 in. high and made from ¼-in. stock. Lute with fire clay between ring and crucible.

TABLE IV. WELDING PORTIONS FOR WELDING RECTANGULAR SECTIONS

Width of Section, Inches	Depth of Section, Inches	Width of Thermit Steel Collar, Inches	Thickness of Thermit Steel Collar at Center, Inches	Quantity of Railroad Thermit Required for Weld, Pounds
3	2	4	1	40
3	2½	4	1	40
3	3	4	1	45
3	3½	4	1	50
3	4	4	1	55
4	4	4	1	65
4	4½	4	1	65
4	5	4	1	70
4	5½	5	1¼	75
4	6	5	1¼	75
4½	4½	5	1¼	70
4½	5	5	1¼	75
4½	5½	5	1¼	75
4½	6	5	1¼	80
5	5	5	1¼	75
5	5½	5	1¼	80
5	6	6	1½	85
5	7	6	1½	90
5½	5½	6	1½	85
5½	6	6	1½	90
5½	7	6	1½	110
6	6	6	1½	100
6	6½	6	1½	120
6	7	7	1⅝	130
6½	6½	7	1⅝	130
6½	7	7	1⅝	150
6½	8	7	1⅝	160
7	7	7	1⅝	155

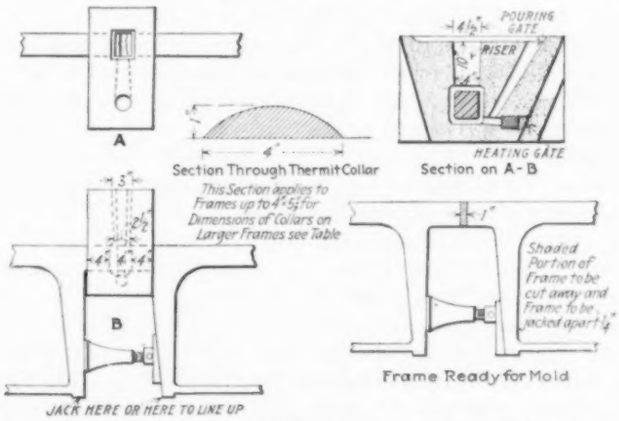

A
Section Through Thermit Collar
4½" POURING GATE
RISER
HEATING GATE
Section on A-B
This Section applies to Frames up to 4"×5" for Dimensions of Collars on Larger Frames see Table
B
Shaded Portion of Frame to be cut away and Frame to be jacked apart ¼"
Frame Ready for Mold
JACK HERE OR HERE TO LINE UP

FIG. 16. METHOD EMPLOYED IN WELDING LOCOMOTIVE FRAME BROKEN IN JAW

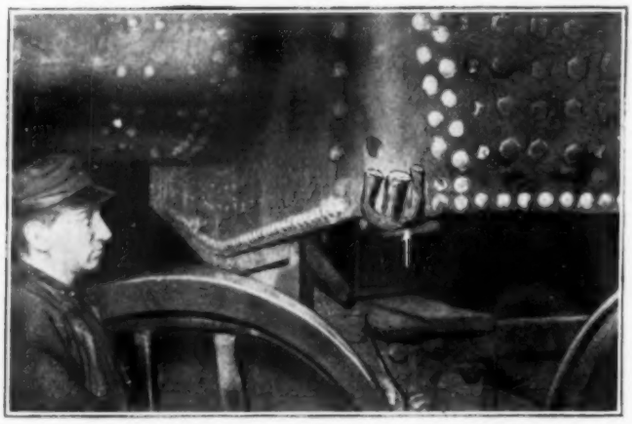


FIG. 19. THERMIT WELD ON MUD RING

When it is assured that the frame is at a good workable heat quickly remove the preheater and direct it down the riser so as to blow out any sand or dirt that may be in the mold. If the riser is difficult of access direct the burner down the pouring gate. Then plug the preheating hole with a piece of fire brick ground to fit or an iron plug inserted as shown in Fig. 10. Back this up with several shovelfuls of molding material between the mold box and steel plate provided for the purpose and then pack the sand down hard with a rammer. This will prevent any possibility of the Thermit steel running out through the preheating opening. All heating apparatus should be removed to a safe distance while the Thermit reaction is in progress.

Place one-half teaspoonful of ignition powder on top of the Thermit in the crucible (Thermit will not ignite from the heat of the preheater and the reaction cannot be started without ignition powder). Ignite this with a parlor match, applying the same immediately after striking, or else ignite with a red-hot iron; this often is the easier method. It is important that ample time be allowed for the completion of the reaction and for the entire fusion of the punchings, which are mixed with the Thermit. It is best to wait at least 35 sec. before tapping the crucible. This is accomplished by knocking up the tapping pin which sets in the bottom of the crucible, using for the purpose the tapping spade or a flat piece of iron 1½ x ¼ in. by 4 ft.

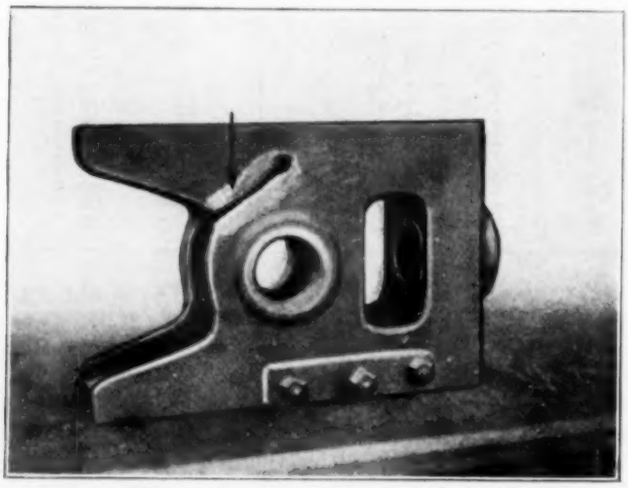


FIG. 20. FRACTURE IN CROSSHEAD CUT OUT FOR WELDING

Hold up the expansion on the parts with a jack or preheater until the metal in the weld has set and shrinkage commences to set in; then remove the jack or shut off the heat. This should be usually done about two or three hours after the weld is made, but depends largely on the size of the section and length of preheating.

The mold should be allowed to remain in place as long as possible, preferably over night, so as to anneal the steel in the weld. In no case should it be disturbed for at least six hours after pouring.

After removing the mold, drill through the metal left in the riser and pouring gate and knock these sections off, or else cut them off with an oxyacetylene torch.

The amount of Thermit needed for welding sections of different sizes can be derived from Table IV, which contains the proper proportions of manganese, nickel and punchings. These amounts are given on the supposition that the Thermit collar or reinforcement is made in accordance with the dimensions published in the table.

It is better practice, however, to calculate the amount of Thermit needed for a weld from the weight of wax

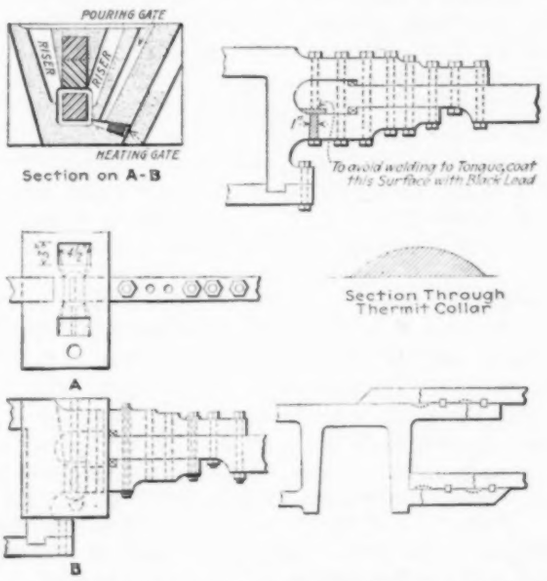


FIG. 17. METHOD OF WELDING FRAMES BROKEN IN SPLICE. LOWER DRAWING SHOWS HOW TO DRILL AND CUT THE UNBROKEN MEMBER

used in the pattern and it is advisable anyway to make this calculation as a check.

Where the quantity of Thermit is calculated from the wax great care should be taken to see that the entire space which is to be filled with Thermit steel is filled with wax so that not only the collar but the space between the sections is filled with wax. Then, by weighing the wax before and after the completion of this operation, the difference will be the quantity of wax used, and this weight in pounds multiplied by 30 will give the proper amount of railroad Thermit for the weld.

It is recommended that railroad Thermit be used in all cases, as it is ready mixed with 1 per cent. pure manganese, ⅜ per cent. nickel shot and 15 per cent. mild-steel punchings. This has been found to give the best results for welding wrought iron and steel. For convenience railroad Thermit is supplied in waterproof paper bags holding 29½ lb. of the mixture, so that one bag to the pound of wax is sufficient for a weld. This

rule provides ample Thermit steel not only for the weld proper, but also for the pouring gate and riser.

In case the user has only plain Thermit on hand he should then allow 25 lb. of plain Thermit to the pound of wax, and should mix with this amount of plain Thermit 1 per cent. pure manganese, $\frac{5}{8}$ per cent. nickel shot and 15 per cent. mild-steel punchings. In other words, to every 100 lb. of plain Thermit add 1 lb. pure manganese, 10 oz. nickel shot and 15 lb. mild-steel punchings. These punchings must be clean and free from grease or dirt of any kind and not more than $\frac{3}{4}$ in. in diameter by $\frac{1}{4}$ in. thick.

These rules apply only to welds requiring less than 300 lb. of Thermit. For welds requiring more than 300 lb. of Thermit the usual mixture takes 20 per cent. mild-steel punchings with the other additions the same. If railroad Thermit is used add $3\frac{3}{4}$ lb. of punchings to each bag. In special cases it is sometimes advisable to make up a special mixture in order to produce a Thermit steel of essentially the same analysis as the steel in the parts to be welded. Where the amount of Thermit calculated comes to ten bags or more, one of these bags may be dispensed with; that is, instead of using ten bags use nine, or instead of using 20 bags use 18, and

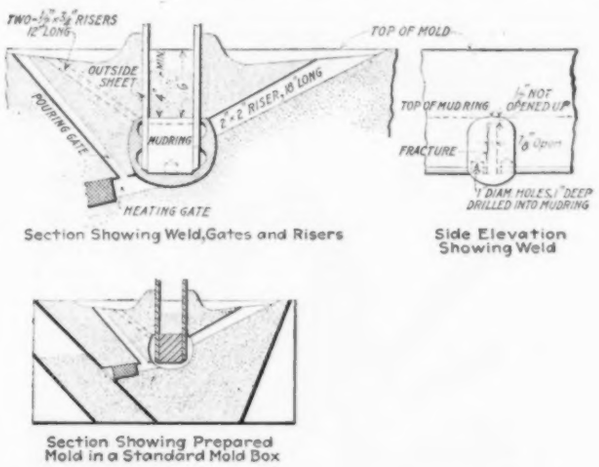


FIG. 18. MOLD FOR WELDING MUD RINGS WITHOUT CUTTING SHEETS

so on, as the smaller percentage of metal required for gates and risers makes it unnecessary to use so much of the mixed Thermit.

Where it is desired to calculate in advance the amount of Thermit required for a weld it is first necessary to estimate the number of cubic inches in the space to be filled with Thermit steel, i.e., the space between the ends of the sections to be welded together and the cubical contents of the Thermit-steel collar or reinforcement fused around the weld. Allow $\frac{3}{4}$ lb. of railroad Thermit to the cubic inch, and this will be sufficient not only for the weld proper but will provide ample metal for pouring gate and riser. In estimating the cubical contents of the collar the simplest method is to multiply the width by the greatest thickness (i.e., the thickness at the middle part); then multiply this product by 0.7. This will give the average area of the cross-section of the collar. If this is then multiplied by the total length of the collar around the outside of the frame and if all measurements are taken in inches the result will be the number of cubic inches in the collar.

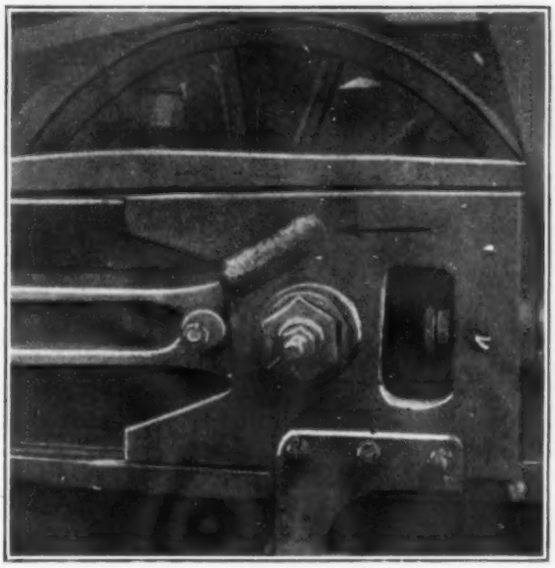


FIG. 21. WELD COMPLETED AND CROSSHEAD IN SERVICE

The foregoing directions refer to the general run of wrought-iron or steel repairs, but with only slight variations the same method is followed for locomotive-frame work. The principal difference is in placing the mold or allowing for contraction in various members and not in the use of the Thermit itself. In order to make it clear where stresses are liable to be set up in a locomotive frame the diagram shown in Fig. 14 has been made. By a careful study of this and the application of the principles illustrated a welder should be able to figure out his work so as to produce satisfactory results.

The illustrations will be of assistance in planning the work on various parts of a locomotive frame. Fig. 15 shows how to place the mold and jacks for welding a broken frame leg. With the pouring gate and risers as indicated they permit of a good washing action for the Thermit steel, so that any slag or sand that might be in the mold will be carried into the risers.

Fig. 16 shows how to weld a frame broken in the jaw.

Fig. 17 shows how to weld a frame broken in the splice. In this it is best in making the repair not only to weld the broken sections together, but also to cut out a piece about 1 x 5 in. of the unbroken member, so the

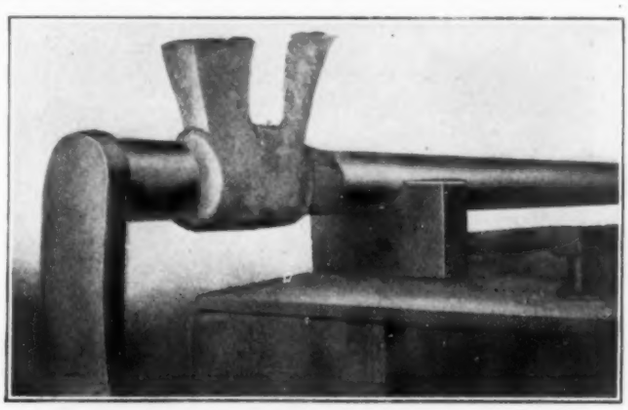


FIG. 22. WELD ON BROKEN ROCKER SHAFT BEFORE MACHINING

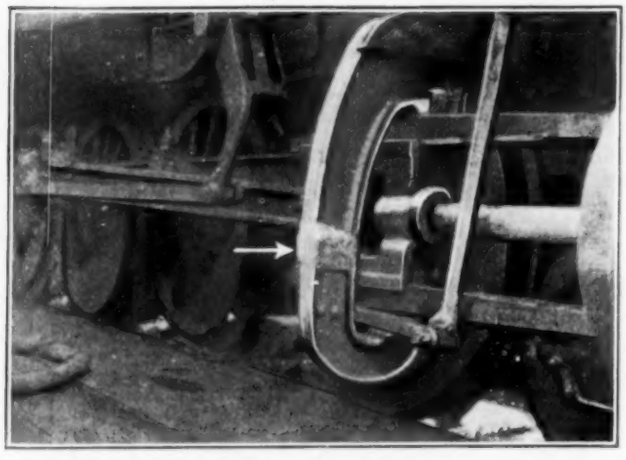


FIG. 23. REPAIR ON BROKEN GUIDE YOKE

Thermit will flow entirely around the broken sections. By making the repair in this manner a good, strong job is assured, and if the bolt hole is welded up and the two members welded together future breakage at these particular points is practically eliminated.

The only objection that can be raised against this practice is the trouble of separating the members in case the splice is to be removed or in order to take out or renew a cylinder. This objection, however, is not serious because it is only necessary to drill a line of small holes where the parts are welded together and the member can then be removed. When replacing it is best to cut a keyway where the frame is cut out and then bolt together in the same way as when the frames were originally assembled.

Fig. 18 shows how to weld locomotive mud rings without cutting the sheets. This method has proved entirely satisfactory and many such welds have been completed and are giving good service.

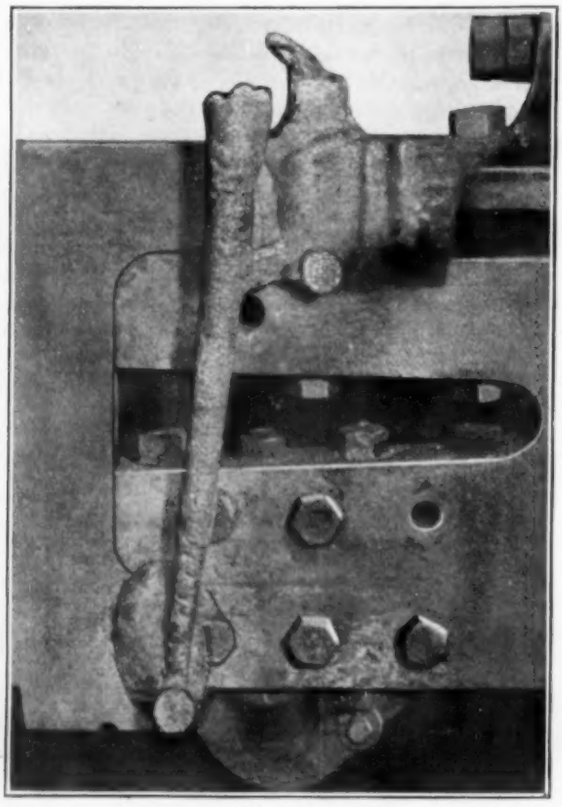


FIG. 24. TWO WELDS IN SPLICE OF FRAME

Fig. 19 is that of a finished mud-ring weld, in which the sheets are not cut.

Fig. 20 shows a fracture in a crosshead cut out for welding.

Fig. 21 shows the weld completed and the part in service.

Fig. 22 shows a weld on a broken locomotive rocker shaft before machining.

Fig. 23 shows a repair on a broken guide yoke.

Fig. 24 illustrates two welds in an engine splice.

Fig. 25 is a repaired driving-wheel center.

Fig. 26 shows details of a crucible holder for frame welds.

No attempt has been made to make the list of repairs on locomotive parts complete, but enough has been shown to serve as a guide for practically everything that is apt to confront the practical man. For superheater work, or pipe work of any kind, the directions given under the heading of pipe welding will cover all that is necessary.

As a sort of recapitulation of the foregoing directions, it will be well to keep the following "don'ts" in mind when getting ready for all locomotive Thermit-welding work.

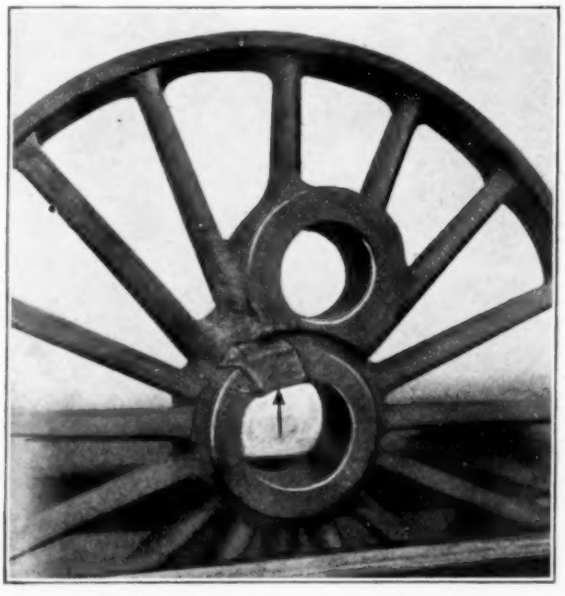


FIG. 25. WELD ON DRIVING-WHEEL CENTER

Don't keep your material and appliances in a damp place. Better store them all in a good, dry room under lock and key, the foreman in charge of the Thermit work to have the key. Better still construct a tool wagon and keep all Thermit material in it.

Don't start to make a Thermit weld unless you have all the necessary materials and appliances and the latter in good condition.

Don't neglect to clean the frame thoroughly. Be sure to remove all the grease, paint, etc., and have as good clean metal as possible to work on.

Don't neglect to take care of the contraction that is bound to be set up as the metal in the weld cools. If this cannot be allowed for by spreading the sections with a jack or other mechanical means heat the opposite

unbroken member with the other burner of a double-burner preheater fitted with a flaming-burner attachment. If this is not available hang a basket fire of charcoal or coke about the unbroken member and heat until proper expansion is obtained, holding up the heat for two or three hours after the weld is poured. It is advisable to expand the frame $\frac{3}{16}$ in. on the average. Cut out the frame along the fracture so as to make a clean opening 1 in. wide. Proportion your wax pattern to the size of the frames as shown in the table.

Don't use pin grease or wood in place of wax for the collar. Pin grease has some sulphur in it and we all

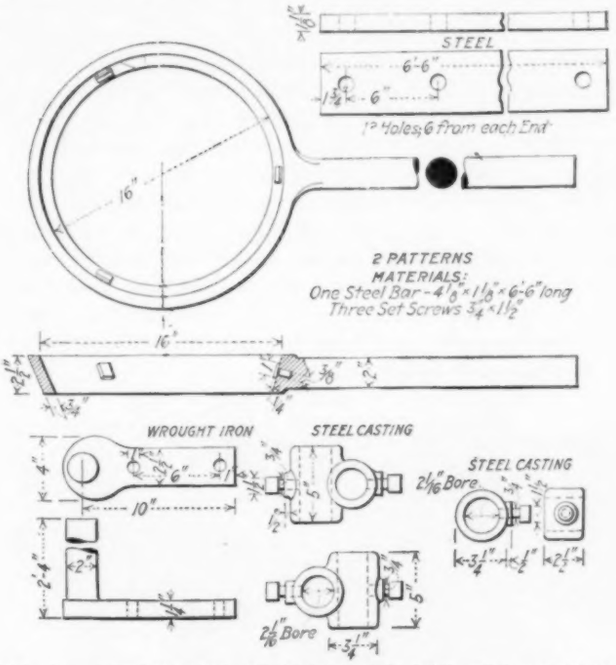


FIG. 26. DESIGN FOR CRUCIBLE HOLDER FOR LOCOMOTIVE-FRAME WELDS

know how undesirable the presence of sulphur is in iron or steel. Pin grease and wood of course burn out in the preheating, but they leave a carbon deposit that will not burn off but will bake on.

Don't vary the dimensions of the wax collar. Make collars of uniform width and thickness on all sides, thus insuring an even distribution of heat. In the case of welds on pedestal legs cutting down the thickness of the collar is poor policy. Remember that the weld is the object and the weld will not be perfect if the dimensions of the collar are not the same on all sides.

Don't moisten the molding material too much. Have it damp enough to bind under the natural pressure exerted in closing the hand.

Don't use a molding material that runs to slag in the course of preheating; if it will not stand the preheating torch it surely will break down to slag, as the Thermit steel flows into it, and a mixture of slag and steel is not at all desirable and furthest from a perfect weld.

Don't forget to support the frame and mold box by means of blocks or jacks, as the weight of the rammed mold is considerable and sag the frame.

Don't start off the preheater with too strong a blast. Take it easy at the start and increase the air and gasoline as the moisture is driven out of the molding material. In this way the mold will not be cut out and a clean-looking job will be the result, with no lumps.

Don't pour the Thermit on a black-hot frame; heat it to a good workable heat.

Don't use crude or fuel oil to preheat the frames. In starting the burner of a heater using either, carbon is deposited on the frame and prevents a good weld. Heat preferably with gasoline and compressed air. If gasoline is forbidden use kerosene, but under no circumstances use crude oil or fuel oil.

Don't be careless in plugging the crucible. Careless plugging results in premature tapping, and this latter might lead to ugly looking or defective welds due to the imperfect separation of slag and steel.

Don't guess how much Thermit to use. Consult the table of instructions and you will not go astray.

Don't use anything but railroad Thermit for welding a steel or wrought-iron section. For cast-iron sections use cast-iron Thermit.

Don't add the ignition powder to the charge in the crucible until ready to start the reaction. It is advisable to suspend the crucible in place, charged with Thermit, before starting to preheat. Everything will then be ready for pouring at the proper time.

Don't tap the crucible too soon after starting the reaction. On an ordinary frame weld taking from 65 to 100 lb. of Thermit permit 35 to 40 sec. to elapse between starting the reaction and tapping the crucible. This to insure good separation of steel and slag.

Don't release the spreading bar or jack or take off heat too quickly after pouring. It is best to hold up the expansion for two to three hours before removing jack or shutting off heat.

Don't remove the mold box too quickly after the pour. Let it remain in place over night; it will insure the frame cooling off slowly and naturally.

Don't forget to gather up all the materials and appliances after completing the work. Take them to the room that you ought to have for the storage of this material and it will be at hand when you want to make use of it again.

Don't get excited—keep cool.

Don't take a chance. Be sure everything is right as you go along. There is no such thing as luck.

Also remember that the riser must be 2½ x 4 in. at the bottom and 3 x 4½ in. at the top and not less than 14 in. high where clearances will admit. In the case of welds on vertical members two risers should be used, but their total capacity need not be greater than the riser for which dimensions have been given. The pouring gate must be not less than 1 in. in diameter at the bottom, 1½ in. in diameter at the top and 30 in. long. Mold boxes should be made of $\frac{3}{16}$-in. sheet iron, allowing for at least 4 in. of molding material on all sides of the Thermit steel.

A Remarkable Feat of Engine Assembling

SPECIAL CORRESPONDENCE

The triple-expansion marine engines here shown were recently assembled in record time at the Wetherill shops of the Sun Shipbuilding Co., Chester, Penn.

Each engine weighs about 400,000 lb., and is 25 ft. high, 25 ft. long and 14 ft. wide. The cylinders are 27 in., 45½ in. and 76 in. respectively in diameter by 51

in. stroke, operating under a pressure of 190 lb. per square inch.

The work of assembling was started one morning at 10:30 o'clock. The components of the engines, such as the bedplates, columns, cylinders, bearing caps, crankshaft, rods, etc., were lying on the floor in various parts of the shop just where they had been dropped when the machine and floor hands had finished work on them.

The machine and hand work had been completed on all the parts except the piston and pump rods. These were finished with the exception of cutting them to length, which could not be accomplished until the cylinders were in place.

By 12 noon of the same day the crankshafts were in place and all the bearing caps were fitted and adjusted. Besides this all the housings, except two, were in place and bolted down, these two being the back housing on the low-pressure engine of the one set and the front housing on the high-pressure engine of the other set.

The first night the men worked overtime till 10 p.m., by which time all the connecting-rods on both sets of engines and all the valve gears were in place. During the first day there were two lunch periods.

On the second day work was resumed at 7:15 a.m., when the cylinders were placed, and as each one of them was set and bolted down the crank under it was turned to top position so that the length of the piston-rod coul be measured. While the other cylinders were being set the piston-rods were turned to length. For this work three lathes and three extra men were used, each of the men doing the work on two of the rods.

The valves were next put in and set, and the handling, reversing and turning gears and the air pump were installed and the latter connected up with the levers. On this day there was no overtime.

Work was begun at 7:15 on the third morning and the entire work of assembling both engines was completed by 5:45 p.m. that afternoon.

The total time consumed in assembling the two sets of engines was 30½ hours, and the force employed on the job, exclusive of the three lathe hands, who worked part time only, was 15 men.

During practically the whole of the time the usual routine work of the shop was carried on and the single traveling crane served the entire shop.

This work is not usually accomplished in this way, the assembling of marine engines being a somewhat prolonged series of operations, depending on the number of men and finished parts available, but as a basis for comparison under ordinary shop conditions and usage three weeks would not be considered unreasonable to assemble each of these engines.

PAIR OF 3000-HP. TRIPLE-EXPANSION MARINE ENGINES ASSEMBLED BY 15 MEN IN 30½ HOURS

Teaching Thrift Through Thrift Stamps

By LUTHER D. BURLINGAME
Industrial Superintendent Brown & Sharpe Manufacturing Co.

The sale of Liberty bonds and stamps taught many lessons in saving. Whether the habit of thrift is to become permanent largely depends on how the future sales are handled. The suggestive value of Mr. Burlingame's article is great and deserves careful study.

DURING the war employees in the industries have learned much in lessons of thrift, but now that the war is ended there is great danger of a reaction and a return to old habits, especially among those who have previously been habitual spenders. This danger exists even where saving has been fully voluntary either from patriotic motives or with a purpose of laying up for future needs, but especially where saving has been somewhat under compulsion due to the force of public sentiment or pressure from shop-

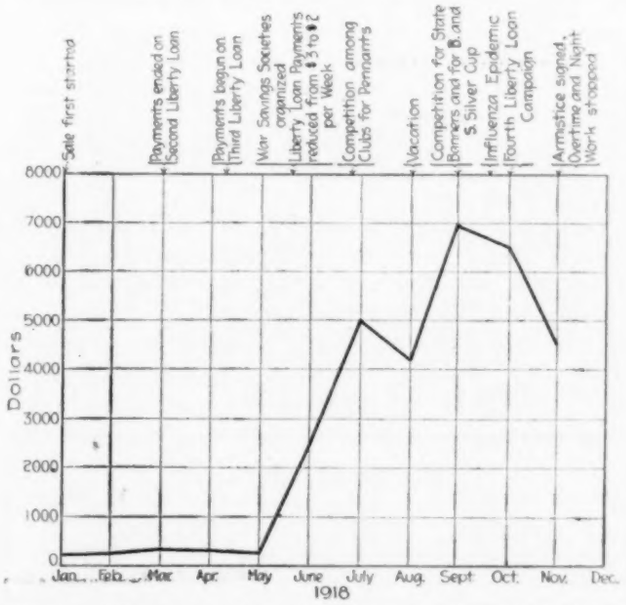


FIG. 1. MONTHLY SALES OF WAR-SAVINGS SOCIETIES, BROWN & SHARPE MANUFACTURING CO.

mates or foremen. There is a prospect that unless rightly guided there will be not only a giving up of the habit of saving, but of going to the other extreme and dissipating what has already been saved.

There is therefore special need at this time on the part of those having the interests of the employees of American industries at heart to take prompt and constructive measures to conserve what has proved one of the greatest assets of the war—the development of thrift.

In the critical time during the transition from war to peace an index of whether the gains in thrift which have been made can be held will be found in the continuance of interest in the purchase of War-Savings stamps of the issue of 1919, and whatever can be done to stimulate such an interest will be a direct factor in strengthening the fiber of our national economic life. The organizing and maintaining of War-Savings societies in industrial plants can be an important aid in attaining the desired end.

To aid those manufacturers who seeing this need are willing to do their part to meet it, but who have not as yet worked out successful methods of so doing, a detailed account of a plan in operation at the works of the Brown & Sharpe Manufacturing Co., Providence, R. I., is here given. This plan has brought gratifying results during the past year.

A year ago when the sale of Thrift stamps was first introduced in these works arrangements were made to have responsible men in each department take orders and secure stamps for the employees through a central distributing headquarters in the cashier's office. To inform employees of this plan a notice pointing out the financial advantages of this form of investment and appealing to the workman's patriotism as well as his self-interest was put in each pay envelope.

With about 7000 employees this brought a response of but a few hundred dollars a week. Even this was felt at the time to be a fair showing as compared with

BROWN & SHARPE WAR SAVINGS SOCIETIES

After this week the amount deducted for Liberty Bonds will be $2.00 instead of $3.00 for each $50.00 Bond, and it is hoped that a large number will continue to save the difference by investing it, or at least part of it, in Thrift Stamps. You can also help by turning your Liberty Bond coupons into Thrift Stamps.

Will you continue to help by organizing or joining a War Savings Society for the purpose of purchasing Thrift Stamps regularly each week?

We will co-operate in the organization of these Societies in our Works. Let us set 100% membership as our goal.

BROWN & SHARPE MFG. CO.

June 10, 1918.

I will join a Brown & Sharpe War Savings Society and will purchase ..... Thrift Stamps per week, at 25 cents each.

Signed .....

Please hand this when signed to the representative in your Department through whom War Savings and Thrift Stamps are now being purchased.

BROWN & SHARPE MFG. CO.

June 10, 1918.

FIG. 2. FRONT AND BACK OF SLIP INCLOSED IN THE EMPLOYEES' PAY ENVELOPE

what other shops were doing, because deductions of $3 a week were then being made for Liberty bonds from the pay envelopes of a large proportion of the working force.

When in March the payments had been completed on the Second Liberty bonds and there was a short period before the next bond issue was floated, a second appeal for the purchase of Thrift stamps was made, also through the pay envelopes. This brought a slight increase during the month, as is shown by the graphic diagram, Fig. 1, but the results still showed no general response and indicated a lack of vital interest in this plan of saving as it had been presented.

The purpose of this article is not, however, to describe such plans, which gave at best only small returns, even though to an extent paving the way for later success, but to show how when the matter was really taken

FIG. 5. CERTIFICATE GIVEN WINNING CLUB AND PENNANT AWARDED WEEKLY

up in earnest, and with sufficient attention to formulate and carry out in detail a comprehensive plan, the returns at once jumped to more than 20 times what had previously been received, putting this saving system on a stable basis, which has since shown a healthy growth.

It is believed that the secret of success lay first in arousing individual interest through personal responsibility, and second in exciting a keen spirit of rivalry through competition.

In order to bring about interest through a feeling of individual responsibility it was decided to organize War-Savings societies, each having a comparatively small number of members, with its own president and secretary. These societies were grouped so that members would be as far as possible in the same department or subdepartment. In some cases the women in a department were in one club and the men in another.

In order further to give the clubs a feeling of individuality and permanence certificates were filled out, each with the name of the club and also the names of the officers, and these were passepartouted with a glass front and eyelets at the back so that they could be conveniently hung in plain sight. (One of these certificates is shown above the pennant in Fig. 5.) The good effect of these framed certificates was at once evident, as they formed a rallying point of interest for each club and tended to dignify the movement and show that it was being taken up in earnest.

Each of the clubs selected its own name, the interest aroused over the selection of these names being the first indication of real enthusiasm which showed itself and it is believed had a marked influence in making the members of the clubs feel a personal interest in their success and in getting them thought about and talked about among the employees. Some of the striking names which were given were: "Victory," "100 Per Cent. American," "Over the Top," "General Foch," "Anti-Kultur," "Baby Bond," "Kaiser's Koffin," "On to Berlin," "Uncle Sam's Nieces," etc.

Many of the clubs were named for shopmates in the service and several were named for shopmates whose lives had been sacrificed for their country. With such names to live up to there was an added stimulus for response to the extent of sacrifice in turning in funds.

The division into clubs with a comparatively small number of members secured the two advantages already pointed out as essential to success—one to give responsibility and arouse interest by having a large number holding official positions; the other organizing homogeneous units for purposes of rivalry.

In order that there shall be the least interference with regular shop work it is important to have as the officers of the clubs those whose duties will not be seriously interfered with when giving time to this work. For this reason it is well not to have those who are engaged in production work as officers, especially as secretaries, but subforemen, department clerks and even messengers can often fill these offices successfully. In most cases it will be found advisable for foremen or officials to make suggestions almost equal to appointment of the desired officers that the clubs may be started and carried on in harmony with the shop management. If this is done diplomatically, however, it need not offset the advantages which come from the cultivation of a feeling of responsibility on the part of these officers.

THRIFT-STAMP CLUBS

The returns show that there will be a very large increase in the amount of money handled each week for Thrift stamps, and in order to save time the money should be placed in the bag or envelope sent herewith with a slip stating the amount, and this can be exchanged at the office for the required number of Thrift stamps without waiting at the time for the money to be counted, that being left until a later time when it will cause less delay.

The secretaries of the clubs should turn in their money as early as possible each Tuesday, so that you can report to Mr. Blank before 12 o'clock the number of stamps required for that day. When you receive the stamps they should be distributed to each secretary, who in turn will give them to the men in his club.

We send herewith a number of cards (Fig. 8) for distribution to secretaries of the clubs reporting to you, so that they can keep a record of the amounts paid in each week, from which the standing of the clubs can be secured at any ime. We also send some old envelopes, the larger of which can be used for keeping the secretaries' record of payments and the smaller for money paid in by the members.

We have 100 per cent. cards for departments where every employee is a member of a club, and will be pleased to furnish you these on written request. The foremen should be consulted in such cases in order to avoid misunderstanding as to which are 100 per cent. departments.

Whenever a member of a club is transferred to another department of the shop his name should be transferred to the club in that department where payments can be made most conveniently.

Please see that this information, as far as it applies to the secretaries of the clubs, is transmitted to them.

BROWN & SHARPE MFG. CO.

June 18, 1918.

FIG. 3. FIRST NOTICE SENT OUT SUGGESTING THE ORGANIZING OF WAR-SAVINGS SOCIETIES

WAR-SAVINGS AND THRIFT STAMPS

Mr. (Adressed to all foremen):

In order to stimulate a further interest among our employees in saving by the purchase of War-Savings and Thrift stamps it is desired that WAR SAVINGS SOCIETIES be organized in the various departments throughout the shop, these societies to consist of about twenty employees each, each of which will have its own name and elect its own president and secretary, and the members of which will agree to purchase one or more Thrift stamps each week, the money for these to be collected by the secretary and exchanged for Thrift and War-Savings stamps in accordance with the present plan or they can be purchased by the members through any outside source.

After the pay received June 10 the amount deducted for Liberty bonds will be $2 instead of $3 for each $50 bond, and it is hoped that those paying for bonds will as far as possible continue to save the difference by investing it, or at least a part of it, in Thrift stamps. Dividends now due on Second Liberty bonds, and those which will be due on First Liberty bonds June 15, if also turned into Thrift stamps, will increase the earnings from the first investment, and employees should be encouraged to use their coupons in this way.

In order to assist in organizing these WAR SAVINGS SOCIETIES you are asked to appoint a representative (preferably the one who now handles the collections for Thrift stamps) who will be responsible for this work in your department under your supervision. He is asked to be at a meeting at the Apprentice Building on Friday, May 31, at 11 a.m. in order to be instructed as to the details and method of carrying out the plan.

The leaflet herewith gives some general information. There will be a charter, certificate of membership, pins to be worn by the members and other features which should appeal to workmen and tend to create a spirit of interest and rivalry. It is hoped that full coöperation will be given by the foremen themselves becoming members and striving to have as far as possible every employee enroll in one of these societies.

May 28, 1918.

BROWN & SHARPE MFG. CO.

FIG. 4. INSTRUCTIONS TO REPRESENTATIVES AS TO THEIR DEALINGS WITH THE CLUBS

The plan for organizing the clubs was launched by inclosing slips as per Fig. 2 in the pay envelopes. The representative referred to in these pay-envelope slips had been appointed by the foreman of each department, a notice (Fig. 3) having previously been sent to the foreman.

After the appointment of these representatives, and after a meeting for organization, they were sent a special notice, Fig. 4, explaining in some detail the methods to be followed. Following the sending out of the notices in the pay envelopes the representatives made a thorough canvass for membership of the employees in their department who had not already joined. This materially added to the number subscribing. It may be noted that a personal canvass always has a much greater value than either bulletin-board notices or those distributed through the pay envelope. It has been recently estimated by authorities on the subject, after comparing savings-banks deposits which are not solicited with forms of investment and deposit which are solicited, that "personally solicited thrift increases 35 times as fast as unsolicited thrift," and experience in connection with shop insurance and investments seems to confirm this view.

Even with such personal solicitation on the part of the representatives the percentage of membership in some departments was still below what it was thought might be obtained. In order to still further increase the interest a spirit of rivalry was aroused by means of competition between the departments. This was done by posting on the bulletin board throughout the shop the percentages of employees of each department who had become members of the War-Savings societies. The departments having 100 per cent. membership were further recognized by having special certificates to that effect posted in prominent places. It was thus made evident which departments had made a good showing, and which were lagging, and both foreman and workmen in the lagging department were pressed to bring their department up to a better showing.

At this time competition was started between the various clubs by the offer of pennants, shown in Fig. 5, the competition being between comparatively small groups of clubs such as between each group of clubs in the same department or in the same building, or where some other natural division grouped ten or so of the clubs together. It is believed that this was one of the greatest incentives in arousing a real spirit of interest and of competition among the clubs.

PENNANTS INEXPENSIVE

These pennants were inexpensive, costing less than $1 each. There are about 35 of them in competition among the 246 clubs grouped as already pointed out. They are made in bright colors, with small silk American flags fastened at the top, the lettering being stenciled on cambric and having one of the War-Savings societies' buttons pinned within the circle. It is, however, the sentiment and not the intrinsic value of the pennant which counts, and it is believed that they have proved their value to the extent of bringing in thousands of dollars in investments each week, which would not otherwise have been received. This was due to the interest and spirit of rivalry they have aroused, and after months of use the competition has not grown to be an old story and lagged, but still remains keen as to which department will hold the pennant for the coming week.

The conditions of competition for these pennants are

FIG. 6. SILVER CUP AWARDED TO DEPARTMENT WITH THE HIGHEST STANDING

THRIFT STAMP CUP CONTEST.

STANDING OF DEPARTMENTS FOR SEPTEMBER, FIGURED ON A HANDICAP BASIS. HARDENING ROOM, WINNER FOR SEPTEMBER.

DEPT.	% MEMBER-SHIP.	SEPT. TOTAL AMT.	AMT. PER WEEK PER MEMBER.	RATING
*#1 Engineering..	100	$890.05	$15.91	1.891
Hardening.. ...	100	3068.71	4.95	1.328
Mfg.Grind.Mach..	74	3119.37	2.63	1.024
Gear Dept.....	98	1361.19	1.97	.816
Mill.Machine. ..	87	1949.40	1.34	.772
#1 Draft.....	98	573.69	1.82	.747
*Industrial....	100	105.00	2.02	.744
Small Tool....	93	2613.22	.97	.743
Foundry.....	88	1562.43	1.10	.717

Total Number of Clubs, 246.
Total Average Membership, 5,664.
Total Amount Received, $26,844.71
Oct. 9, 1918.

COMMITTEE.
.....
.....
.....

*Not competing.

FIG. 7. MONTHLY RECORD OF STANDING OF VARIOUS DEPARTMENTS

outlined in the following notice, which was sent to the foreman, showing that here again "home rule" and responsibility were encouraged. In order to stimulate personal interest each department determined in detail its own conditions of competition. The notice reads:

Mr.....

The pennant sent herewith is the one to be awarded from week to week to the society in your department having the highest rating or standing. It is suggested that it be hung directly under the certificate of the society winning it for the week.

While the method of figuring the rating and of awarding the pennant is left with you and your representative it is recommended that the rating be based on the Tuesday returns of each society, thus encouraging prompt payments on the part of the members.

If two societies have all or an equal number paid up in full, advance or over payments can be counted as determining the winner for the week.

The following are the societies that are to compete in your department:

.....
.....
.....
.....
.....
.....
.....
.....
.....

In case some of these are under other foremen and representatives the Industrial Department will aid in arranging for the contests.

BROWN & SHARPE MFG. CO.

June 25, 1918.

An illustration of the method of working out rules in local departments is shown by the following seven rules adopted by the grinding department for the pennant competition among its eleven clubs.

1. Only 100 per cent. clubs eligible for pennant.
2. For Day Men—All orders for the following week must be in before 6 p.m. of the Thursday previous.
   For Night Men—All orders for the following week must be in before 7 a.m. of the Friday previous.
3. All Thrift-Stamp books to be exchanged for War-Savings stamps to be turned in Wednesdays, and balance over four dollars ($4) to count for week following.
4. All orders to be sent in sealed envelope with name of club and secretary's name *only* written on the outside.
5. Envelopes to be opened only when witnessed by foreman of department or whom he may appoint.
6. The largest order when paid for on Tuesdays decides the winner.
7. Any infraction of these rules will cause the pennant to be forfeited to next highest club.

The stimulating influence of this local competition for pennants during the months of June and July is shown in the chart, Fig. 1. In the month of August,

FIG. 9. BANNER GIVEN WINNING CLUB IN MONTHLY STATE CONTEST

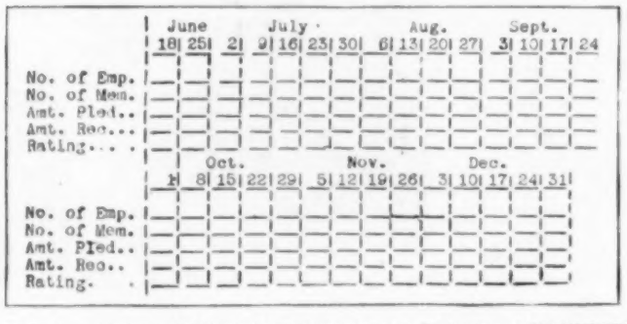


FIG. 8. CARD SHOWING STANDING OF CLUBS EACH WEEK

when the shop shut down for its annual vacation week, there followed a reduction, as would be expected; but after vacation a new form of competition was in full swing, this being a competition between departments for a silver cup (Fig. 6) offered by the company for the department in the shop having the best standing.

The chart, Fig. 1, shows how this competition, together with competition for banners offered by the state committee, increased sales until the time of the Fourth Liberty loan, when with the emphasis placed on that form of saving the investment in Thrift and War-Savings stamps naturally dropped. Still later when the

armistice was signed the stopping of overtime and night work brought a still further reduction, all of which are graphically shown.

A committee was appointed to arrange for the cup competition and handicap rules were announced, so as to be fair for large and small departments. To maintain the interest additional rivalry was encouraged by having the cup held each month by the department winning it the previous month. Notices were posted on the bulletin boards announcing the standing of the departments at the end of each month (Fig. 7).

The collection, counting and handling of five or six thousand dollars a week, besides the exchange of Thrift stamps for War-Savings stamps and the distribution of these stamps to more than five thousand members of the clubs, required thorough systematizing in order that it might not become a burden. As the plan was worked out in practice various measures were taken in order to reduce unnecessary work. Some of these measures are explained in the following notice sent out to the representatives:

Mr.....

In order to simplify as far as possible the work of collections from members of the War-Savings societies it is proposed to carry out a plan by which the stamps can be delivered to members of the clubs when they pay the money.

A requisition, as per sample herewith, for the stamps which it is expected will be required the following week should be sent to the paymaster at the general office on or before 9 a.m. Friday of each week. Stamps will then be secured and will be delivered to you early Tuesday morning and through you as representative in your department to the secretaries of the clubs (if there are several) who can then collect from the men.

Collections should be made so as to turn in the completed account with the money, including any stamps which are left over, on Tuesday before 5 p.m.

If there is any considerable amount of money to be held over the noontime this can be deposited in the office safe in the bag you have had provided and the money collected in the afternoon can be added to this amount when settling.

Any stamps which are wanted other days than on Tuesday can be secured as heretofore at the designated hour in the afternoon. This plan should be put into operation so that the first requisition will be handed in by you before 9 a.m. Friday of this week.

BROWNE & SHARPE MFG. CO.

June 20, 1918.

In order to have a complete record from which the standing of each department can be figured, entries are made of each club's standing on cards (Fig. 8) and from these the required data are obtained.

Beginning in September further competition was stimulated by the offering on the part of the State Director of awards for the highest subscriptions per member in clubs throughout the state, and of "Distinguished Service" ribbons for individual members of clubs making the greatest personal sacrifice in purchasing Thrift stamps. The club awards were in the form of silk banners (Fig. 9), and the great degree of interest which had been aroused among the 246 clubs at the works of the Brown & Sharpe Manufacturing Co. is shown by the fact that in the month of September 10 out of the 25 awards to societies in the state came to Brown & Sharpe clubs, and even a larger number in the month of October (the last as yet reported).

The form of report rendered to state headquarters by the secretary of each society in this competition is shown in Fig. 10.

STATE COMPETITION WAR SAVINGS SOCIETIES

MONTH OF DECEMBER, 1918.

Society Name..... No. of Members.....

Dept..... Foreman.....

Actual Money received at B. & S. $.....

" " value of outside purchases $.....

Total Amount $.....

Amount per Member per Month $.....

Total Number of War Savings Stamps purchased at B. & S.....

Special cases, "Individual making greatest Sacrifice" for Distinguished Service Ribbon.

..... Secretary.

FIG. 10. FORM OF MONTHLY REPORT TO STATE HEADQUARTERS

To show the amount of thought which was given and interest which was aroused among workmen in these various contests a cartoon, which was made by a member of one of the clubs, is here reproduced (Fig. 11). This shows a circus striker, with the names and relative standing of the 11 clubs in the cartoonist's department indicated on the backboard, with one of the workmen who had invested $126 in one week, represented as wielding the beetle, ready to give the Kaiser (pictured as the striking block) a finishing blow. The foreman of the department is shown in the upper right-hand corner holding up the prize silver cup and encouraging his men to strive to secure it. At the right is shown a workman who held out against joining a club until the last, but eventually "surrendered"—"Kamerad." At the left one of the workmen is pictured as selling his automobile to invest in War-Savings stamps, and telling one of the "boys" whom he has previously taken home in his machine at noontime that hereafter he will have to walk.

Where the workmen show such a spirit of interest as

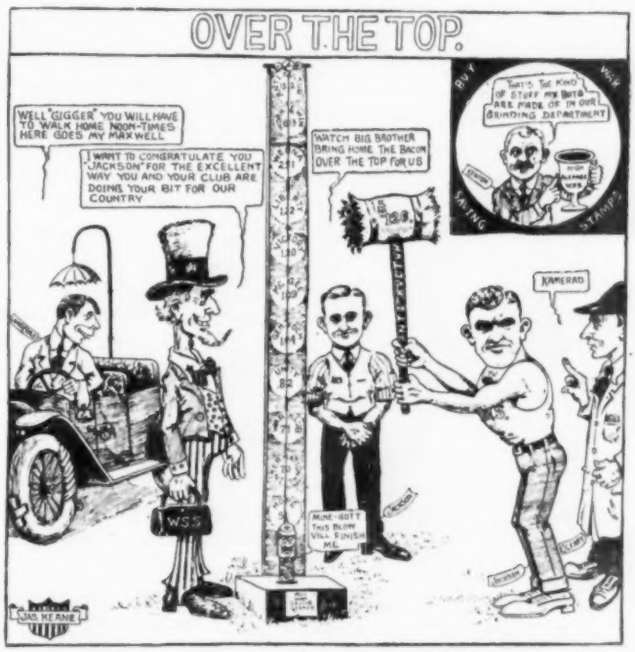

OVER THE TOP.
WELL "GIGGER" YOU WILL HAVE TO WALK HOME NOON-TIMES HERE GOES MY MAXWELL
I WANT TO CONGRATULATE YOU "JACKSON" FOR THE EXCELLENT WAY YOU AND YOUR CLUB ARE DOING YOUR BIT FOR OUR COUNTRY
WATCH BIG BROTHER BRING HOME THE BACON OVER THE TOP FOR US
KAMERAD
WSS
JAS. KEANE

FIG. 11. CARTOON BY AN EMPLOYEE WHICH LIVENED UP THE CONTEST

is indicated by this cartoon the project which they are undertaking is bound to succeed. The results are far more satisfactory to the employees themselves and in their relations to the company than if pressure were brought to bear, which would make them feel that they were being forced.

It is believed that important results have been reached through War-Savings societies in addition to the mere saving of money, these results being in the cultivation of thrift and the development of an *esprit de corps;* thrift in that employees are taking a more personal interest in saving, because by this method they see the results visualize and grow more tangibly under their eyes than by other methods; *esprit de corps* in that there has been developed a sense of team work and department spirit, with an ambition to stand well or excel, thus developing a feeling of responsibility on the part of those conducting and aiding the local clubs.

The 1919 issue of War-Savings stamps can through the aid of employers be made an increasingly popular form of investment for factory workers. With such help on the part of the employers during the coming year this plan of saving should become so well established and of such recognized value that it will be made permanent by the Government as a part of our industrial life because of being the best means so far devised to make saving easy and popular with small investors.

Jottings of a Journeyman

By F. L. Ess.

"Speaking of Garabed," said the boss to me one day, "reminds me of an experience I had in the old bicycle days before the automobile was invented.

"One day when I was out a woman came into the shop with an idea on bicycles which she thought would be a great thing and which she wanted developed. She was accompanied by a man who was to pay the bills.

"She had been sent in by the proprietor of a neighboring shop where we had had work done; in fact he came in with her himself to introduce her to me, a favor which she seemed to greatly appreciate. He said that he was too busy himself to do the work for her. (Strange how busy people can be sometimes.)

"The lady's idea was to have the weight of the rider drive the bicycle ahead by some sort of mechanism to be operated by a falling seat, each descent driving the bicycle ahead about four hundred feet. During the latter part of the descent the weight of the rider was to compress a spring which on being released at the last moment was to throw him up to the starting point again, when he would be ready for another four hundred feet. She said that she did not believe in perpetual motion, but thought her idea had something in it worth while. The foreman was not greatly impressed with the idea, but did not like to take the responsibility of turning her down, so he sort of kept her on the string until I came in.

"Perhaps I was rather more abrupt with her than I should have been had my chivalrous instincts been stronger, but the idea of the machine's giving the rider a shoot in the stern to start him on his new descent was a little too much for me.

"The woman seemed to take my rebuff a good deal to heart and I never saw her afterward, but the funny part of the whole business to my mind was that Jones, the proprietor of the neighboring shop, came in the next day and gave me a regular call-down for what I had done.

" 'You don't want,' he said, 'to tell people right out that their ideas are no good even though you may know that they are not. You want to sort of lead them on and let them think that they have got something worth while. It makes business good.'

"The morality of this sort of policy did not impress me much more favorably than the woman's bicycle idea had done, but as he was considerably older than I, I did not say much.

"I have since wondered though," the boss continued, "just how far one should go in either criticising or approving a customer's ideas. I have had customers

whose ideas seemed good but which afterward proved worthless. One such case in particular I have in mind where for the sake of the business which I thought it might bring me I made certain suggestions to a customer in the way of perfecting his invention, which he adopted, but though my improvements were in themselves all right the thing as a whole was no good, and the man was out perhaps a thousand dollars, for which I felt in part at least to blame.

"At other times I have had customers whose ideas seemed so poor that I made free to criticise them, with the result that they were offended and took their work elsewhere and showed that they knew what they were about by making good.

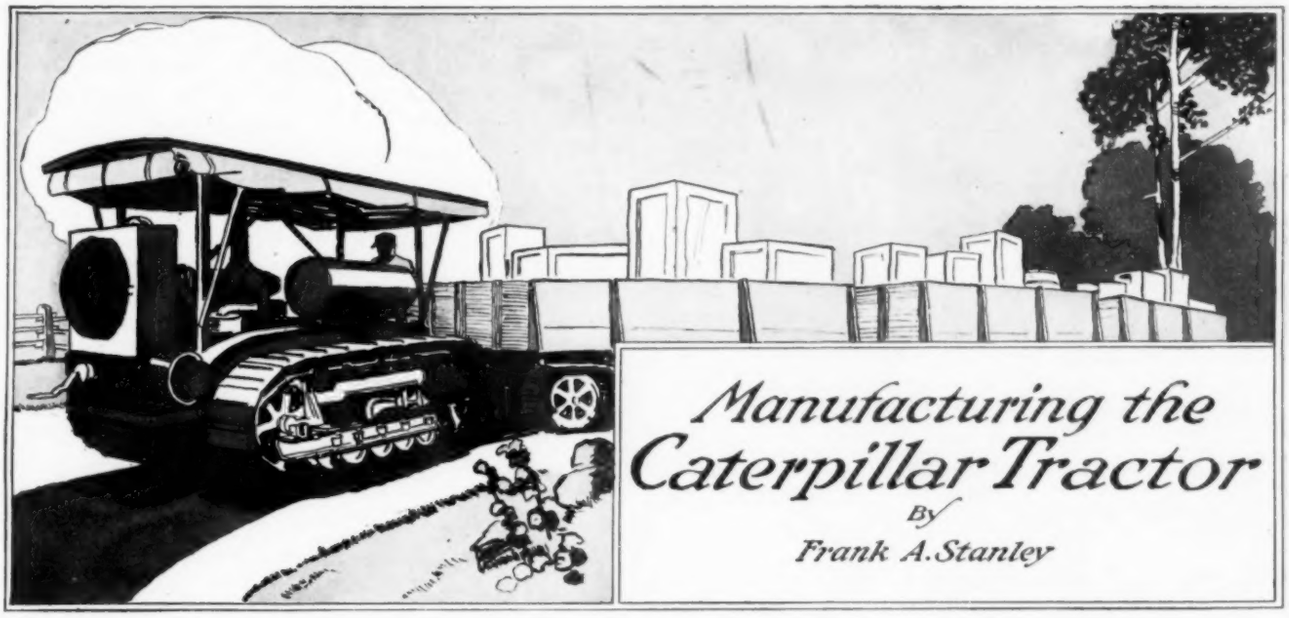
"So on the whole," the boss continued, "I have given up either approving or criticising customers' ideas and confine my suggestions wholly to details of construction. But when it comes to anything savoring of perpetual motion I want the man to have his drawings fully made."

Tracing by Transmitted Light

By G. E. Michaels

Having occasion recently to work up data from some old blueprints that were so faint as to be untraceable I rigged up a transparent topped table by making a wooden frame on top of an ordinary table and setting in the glass from a blueprint frame. There was space enough between glass and table top to introduce an electric lamp which could be moved about as desired.

Stretching the faded blueprint face down over the glass, the tracing cloth on top of it, and working by transmitted light, the tracing was an easy and expeditious job.



Manufacturing the Caterpillar Tractor

By

Frank A. Stanley

VI. Cylinders, Pistons and Crankshafts

This article describes and illustrates the boring of cylinders with cutters that are remarkably long lived and that hold the bore to dimensions within very close limits so that subsequent grinding operations are accomplished with facility. The turning and grinding of cylinders, pistons, pins and crankshafts are also described in this article.

THE cylinders of the "Caterpillar" tractor engines built by the Holt Manufacturing Co. in its Stockton plant are bored and faced in the manner indicated in Fig. 50, where a 6¼-in. cylinder for a 75-hp. motor is illustrated in place in a boring mill with the cutter head and facing arm in operation. Four of these cylinders are required for each motor, and they are therefore manufactured in very large numbers. The length of bore proper in this size of cylinder is 12 in. and the counterbore is 2½ in. deep, so that the total length of machined surface through the casting is 14½ in. The high and low dimensions to which the cylinder boring is held are respectively 6.488 in. and 6.483 in., leaving from 0.015 to 0.020 in. for grinding, the five-thousandths limit of accuracy in the boring process being reduced in the grinding to a limit of one thousandth inch only. The figures for the latter are as noted in Fig. 51, 6.504 and 6.503 inches.

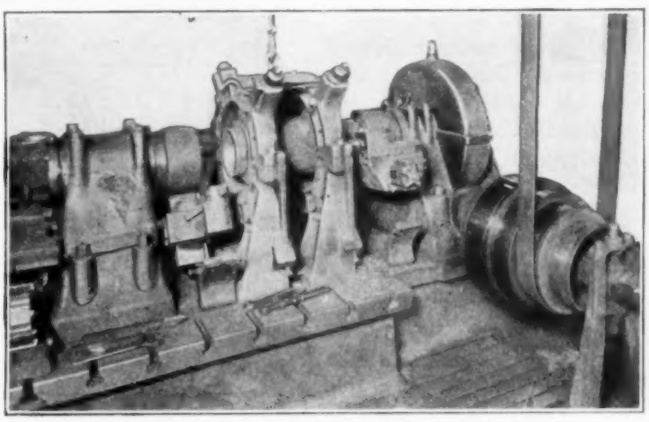


FIG. 50. BORING THE CYLINDERS

The boring machine is fitted with fixtures that enable the cylinders to be set quickly in place for machining and which, from being so, grip the work so as to prevent distortion of the castings. The boring spindle for the cutter heads also carries the facing arm for the bottom flange of the cylinder and the facing tool is operated simultaneously with the cutters for either boring or counterboring the casting.

The facing tool is seen in operation in Fig. 50, and the manner in which it is operated by star feed is apparent.

The boring heads for this work are generally of Stellite blades inserted in suitable bodies, although in some cases high-speed steels are employed, particularly for the counterboring heads. The results with the Stellite blades are very satisfactory and one of them is illustrated in Fig. 52. While the limits as specified on the blueprint of the cylinder call for an allowance for grinding equal to about 0.020 in., the cutter heads referred to have made possible such close holding to size and such satisfactory surfacing of the interior of the cylinder walls that the actual practice followed with the use of these heads in boring is to hold the work to about 0.010 or 0.012 in., giving a minimum amount for finishing by grinding.

Referring to the Stellite boring head, this inserted blade tool takes out at a single cut all the metal in the cylinder bore preliminary to grinding. It bores out something like ¼ in. of metal on a side and is fed through the cylinder at the rate of $\frac{1}{16}$ in. per revolution of cutter bar.

It is rotated from 23 to 31 turns per minute, approximating a circumferential speed of 45 ft. per minute. The high-speed-steel counterbore for the cylinder end is operated at the same rate of speed, and from 26 to 28 cylinders are bored, counterbored and faced in a day of 8¾ hours. The counterboring operation is held to a limit of 0.002 in. as this end of the cylinder receives the shoulder under the cylinder head and so locates that member in correct position.

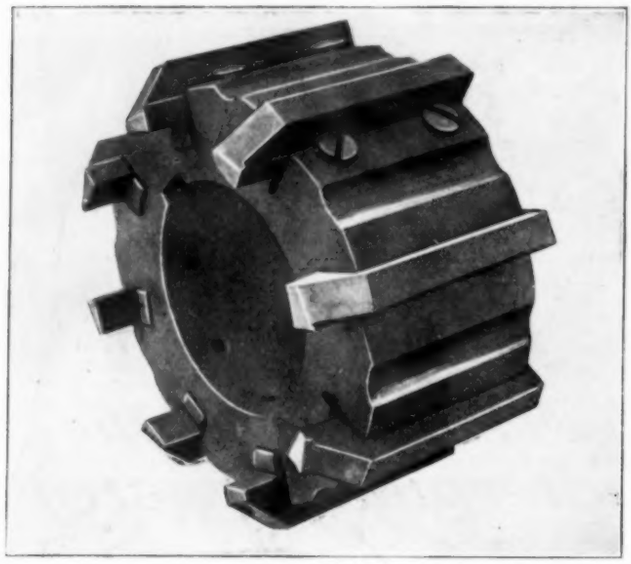


FIG. 52. THE CYLINDER-BORING HEAD

The Stellite boring cutters are used for a long period in steady operation before they show appreciable wear and need of replacement. Two of these cutters have been in service continuously on two boring machines for over a year and still have several months' work ahead of them before they are likely to become worn to a point where they must be discarded. In the time stated they have each bored over 13,500 cylinders of the type shown.

Sharpening Cutters

Ordinarily the cutters are sharpened twice a day of 24 hours. Each sharpening takes off but a few thousandths of an inch from the blade ends, and they are sharpened on the ends only. After 175 or 200 cylinders have been bored the cutter blades usually require setting out radially by careful shimming under their lower edges, but if this operation is performed with judgment the outside diameter does not require grinding to bring the cutting size to standard. About once in two months, however, the outside is ground and the blades cleared again back of the cutting edges to put the cutter head into first-class condition.

Fig. 53 shows what is considered the most desirable method of backing off the teeth at their tops and clearing the cutting ends and incidentally illustrates the manner in which the blades are set into and carried by the cutter head. The blades are ½ in. thick, with a shoulder for the heads of a pair of fillister-head screws for securing the blades in their seats. The method of shimming up under the blades will be understood from Fig. 52.

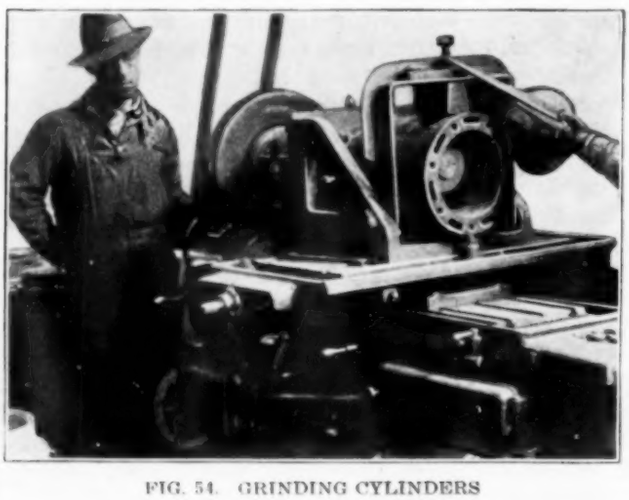


FIG. 54. GRINDING CYLINDERS

Grinding Cutter Blades

The ends of the blades are ground off to an angle of 45 deg., and the outside diameter or outer edge is relieved right up to the cutting edge, leaving no land, but instead a sharp edge which cannot drag or become affected in such a way as to produce unsatisfactory results in the boring of the cylinder.

From Fig. 53 the backing off or relief along the top of the blades will be observed to be from 8 to 10 deg., and the same illustration shows that the cutting ends have a similar amount of clearance. The angles of rake and clearance have been established as the proper ones

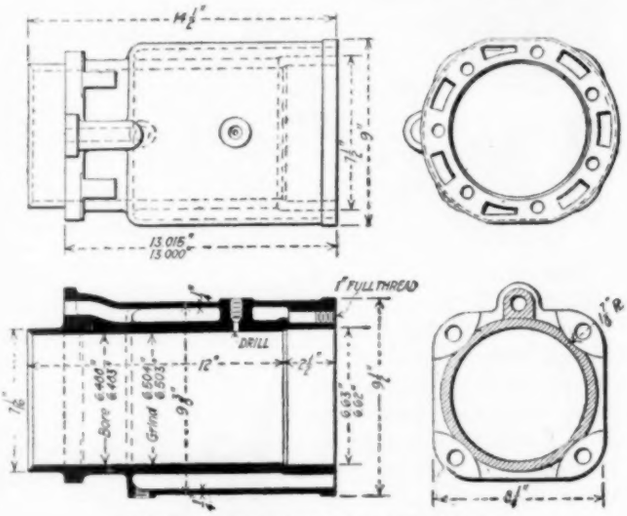


FIG. 51. DRAWING OF CYLINDER

for the work described, and from the foregoing data on the life and stability of the tools it is evident that conditions of cut, clearance, etc., are correct.

The counterboring of the end of the cylinder is accomplished with a cutter head fitted with high-speed-steel blades. The counterbore is roughed out by the passage through of the regular boring head, so that the wear on the counterboring head is correspondingly reduced. The head used for the counterbore operation has been run constantly for over a year and is still serviceable for several months' more work. The diameter of the counterbore is held to within 0.002 in. of standard size.

Grinding Cylinders

The grinding of the cylinders is performed on the cylinder grinding machine shown in Fig. 54, the time required for the operation being 25 minutes.

The method of locating and supporting the cylinder casting in the machine will be obvious from an inspection of the illustration, and requires no description.

The wheel used for the grinding operation is a Crystolon 30J, 5 in. in diameter by ½ in. face. The wheel is run at 5000 r.p.m., equivalent to a peripheral velocity of 6500 r.p.m. The revolving head, which carries the wheel spindle, makes 75 turns per minute, so that

the travel around the bore is at the rate of 110 ft. per minute. The work is traversed past the wheel at the rate of 2 ft. per minute, or one complete forward and backward movement in that time.

Piston Operations

The pistons are carried through a number of operations before they reach the grinding department. Of these only one is illustrated, the machining of the hole for the piston pin, which is accomplished in the heavy turret lathe, Fig. 55.

The piston pin is a hollow member which is fitted into the cross-holes of the piston, which are bored to 1.9375 in. and 1.875 in. diameter, as indicated in Fig. 56. The boring and the machine reaming are attended to on the turret lathe, Fig. 55, where at the same setting the inner ends of the bosses for the pins are machined to the required dimensions.

The piston is held on the faceplate of the turret machine by means of a special fixture in the form of a cradle in which the cylindrical casting is held central in respect to its longitudinal axis and so positioned endwise by suitable stops as to bring the pin hole at the desired distance from the end of the piston.

Two straps, or curved bands, secure the work in the fixture and hold it firmly in place during the boring and

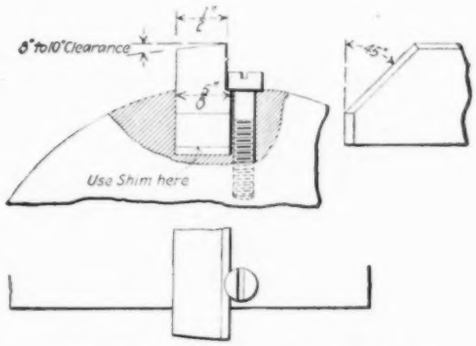


FIG. 53. BORING-HEAD DETAILS

reaming of the holes and the facing of the internal-hub ends.

The machine reaming is followed by a hand-reaming operation in which two or three thousandths of an inch only is scraped out to bring the holes dead to size.

The grinding of the outer diameter is done on a plain cylindrical grinding machine with a 14 x 1½-in. wheel driven at 6000 ft. surface speed per minute. The wheel is an Alundum 26K, and the work is driven at 100 revolutions per minute.

There is left for removing by grinding from 0.015 to 0.020 in., and this is taken off at one pass of the wheel, the feed being operated by hand after the wheel has been set to depth. The feeding is done slowly, taking say 2½ to 3 min. for the movement clear across the work surface. The rate of production from the grinding machine is 14 per hour.

Crankshaft Construction

A typical crankshaft manufactured at the Holt plant is illustrated in Fig. 57. This is a chrome-nickel steel shaft for a 7½ x 8-in. motor and is machined from a drop-forging.

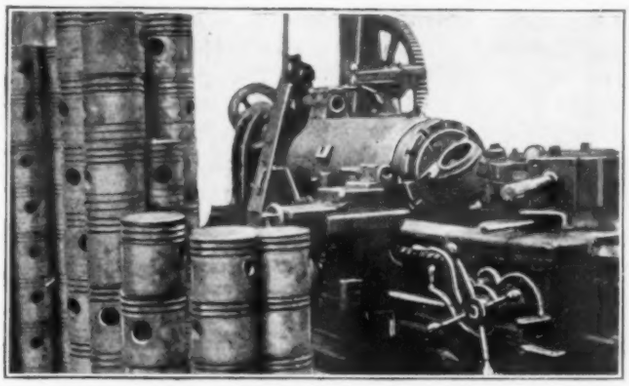


FIG. 55. MACHINING PISTON-PIN HOLES

The drawing is dimensioned for both turning and grinding limits, and it will be noted that the turning is held to 0.004 in. and the grinding to 0.001 in., the amount left by the turning tools for removing by grinding ranging from 0.018 to 0.025 inch.

The drop-forged crankshafts are in the rough about ¼ in. above finished size all the way around. The roughing of the main bearings and the second or finishing cuts are attended to in an engine lathe. No special holding fixtures are required for the work, as it is mounted upon its own centers.

The roughing cut is taken with a depth of chip of about ⅛ in., leaving about $\frac{1}{16}$ in. on a side for the next cut. The feed for roughing is $\frac{1}{16}$ in. per revolution.

The work is driven at the rate of 60 r.p.m. for the first turning operation and the same speed is used for the next turning cut. Here a coarse feed is employed, say $\frac{1}{16}$ in. at least, and about 0.022 in. is left for grinding.

Machining the Crankpins

Crankpin turning operations are represented by Fig. 58, which illustrates a lathe with crank fixtures, arranged as indicated, for carrying the work off center a distance corresponding to the crank throw and enabling the shaft to be set in turning position immediately without preliminary setting in special center blocks. The ends of the shaft are merely slipped into the jaws of the fixture, which is then clamped and the work thus brought into position for the turning of any given pin. For other pins the fixtures are adjusted about their centers to bring each crankpin position into coincidence with the lathe centers.

The amount of metal to be removed from the crankpins is practically the same as for the bearings. The

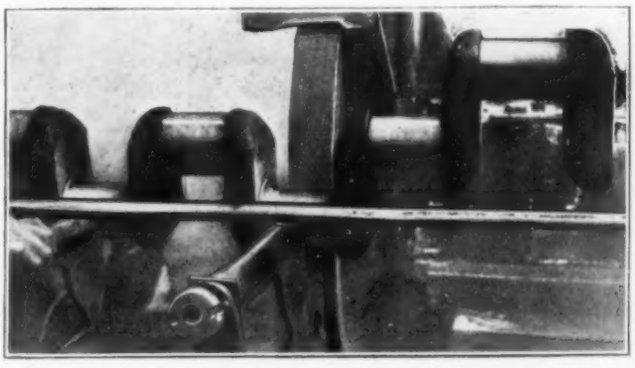


FIG. 60. HOW THE WHEEL IS FED TO THE WORK

pin-roughing operation leaves $\frac{1}{32}$ in. or more on a side for a second turning cut, which leaves the specified amount for finishing by grinding.

The work is rotated at 90 turns per minute and the feed is about $\frac{1}{16}$ in. per turn. The first-roughing lathe on main bearings and the crankpin lathe take care of all of the work on the webs.

Roughing the main bearings is done in 1½ hours. The second turning cut is taken on 10 shafts in a day of 9 hours. The crankpin lathe turns 24 pins, four pins to each of six shafts, in one day's time.

The journals are ground in a 16 x 72-in. machine with an Alundum 36M combination wheel measuring

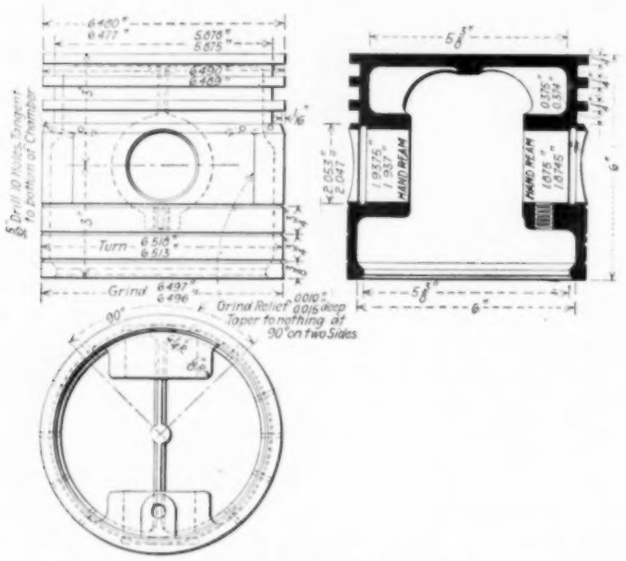

Drill 10 Holes, Tangent to bottom of Chamber
Turn
Grind
Grind Relief .001" .005 deep Taper to nothing at 90° on two Sides
MAIN BEAM
CRANK BEAM

FIG. 56. DRAWING OF PISTON

26 in. in diameter by $3\frac{9}{32}$ in. face. The wheel is driven at 950 r.p.m., or at 6500 ft. surface speed. The shaft is rotated at 60 turns per minute equivalent to 50 ft. surface speed of work. The time required for grinding bearings is 50 min. per shaft.

The pins are ground as in Fig. 59 on a crankshaft grinding machine with an Alundum 36L silicate wheel 42 in. in diameter and $3\frac{9}{32}$ in. wide.

The wheel is operated at 550 r.p.m., this figuring out at 6000 ft. peripheral velocity. The crankshaft is driven at 35 turns, or 30 ft. per minute. The four pins on each shaft require about 30 min. for actual grinding, the total time, including putting in the shaft, setting, etc., and removing when ground, averaging 50 minutes.

The pins are ground before the main bearings. Then, if desired, they are wrapped for protection of the surfaces while the crankshaft is handled for grinding the bearings.

The close-up view in Fig. 60 illustrates the manner of applying the wheel to the grinding of the pins.

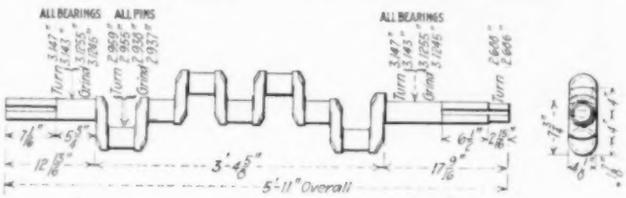


FIG. 57. CRANKSHAFT FOR 75-HP. MOTOR

The length of pin is $3\frac{13}{16}$ in. The wheel is $3\frac{9}{32}$ in. across the face. The pin therefore exceeds the wheel width by only $\frac{3}{8}$ in. The wheel is fed bodily in to a depth to size the pin and to clean up the fillet on one side, then fed into the other side to grind the other fillet. The limit of accuracy here as in the case of the grinding operation on the main bearings is 0.001 in. This limit refers particularly to the shaft illustrated in Fig. 57 and shown in the different stages of manufacture in the various machines ilustrated above. In certain other types of shafts only one-half thousandth inch is allowed for variation in main journals and pins.

Lapping Under Water

By William Hintze

Those who have had occasion to lap hardened pieces of steel of thin section, say from 0.010 to $\frac{3}{32}$ in., know the difficulty experienced from the curling or warping of the work, which is due to several causes, change of temperature and uneven condition of the lap being the principal ones.

I have secured excellent results by placing the lapping block in a pan of water deep enough to cover the work by a couple of inches. Under these conditions there can be no variation of temperature, and as the lap cannot dry out in spots a uniform cutting surface will be maintained.

The main causes of trouble thus removed the lapping may proceed without trouble and the surface may be kept parallel with comparatively little difficulty.

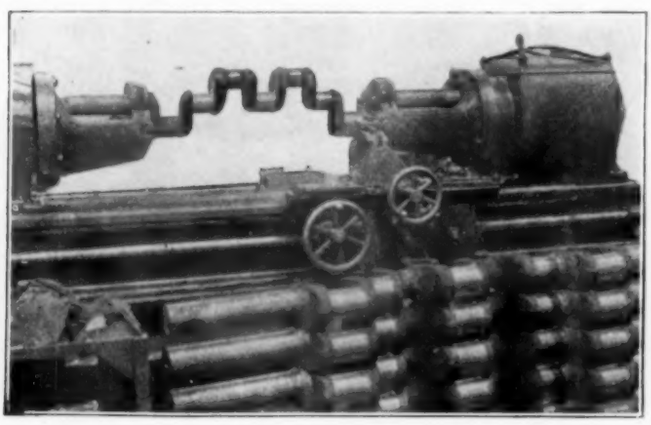


FIG. 58. TURNING CRANKSHAFTS

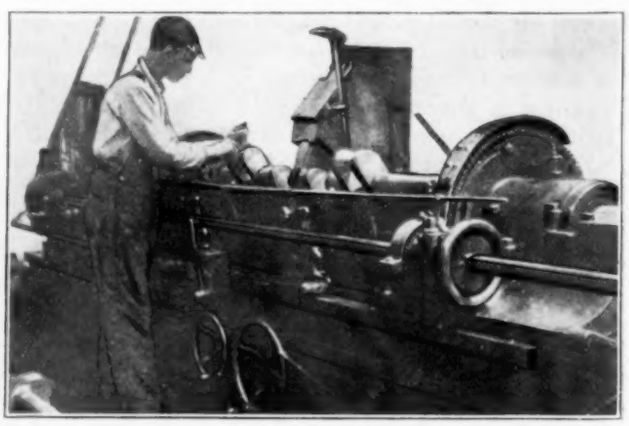


FIG. 59. GRINDING CRANKSHAFTS

How the 155-Mm. Howitzer Is Made—VI

By J. V. HUNTER
Western Editor *American Machinist*

A great many operations are required on the breech-block carrier in order to shape it from the rough drop-forging in which it is furnished into the completed part for service in the howitzer. This article describes the methods used for the production of this piece.

MORE operations are probably required to complete the breech-block carrier than any other single part of the breech mechanism. The general outline of this part is covered by Fig. 97 and the operations are as follows:

Operation 1.—Face back end. Machine—No. 5501. Type—24-in. Gould & Eberhardt shaping machine. Tools—Cutting. Stamp serial number on top of hinge lug with ⅜-in. figures.

Operation 2.—Rough front end and finish-bore. Transformation—Fig. 98. Machine—Nos. 5109 and 5110. Type—24-in. Bullard vertical turret lathe. Tools—Special tool setups, gages. Coolant—Houghton's No. 2 cutting oil. Cut data—Variable.

Operation 3.—Finish back face on arbor. Machine—No. 5220. Type—Reed-Prentice lathe. Transfer serial number with ⅜-in. figures to back face of carrier so that stamping will machine out at operation 21, "Mill slot in lug."

Operation 4.—Finish front face. Transformation—Fig. 99. Machine—Nos. 5252 and 5253. Type—No. 3A Warner & Swasey turret lathes. Tools—Snap gages, etc.

Operation 5.—Thread. Machine—Nos. 5262, 5253 and 5266. Type—Prentice lathes. Transformation—Fig. 100. Tools—Gages, thread-cutting tools.

Operation 6.—Finish joint and locate center line. Machine—No. 5201. Type—25-in. by 10-ft. 6-in. Crawford lathe.

Operation 7.—Mill hinge lug. Machine—No. 5417. Type—No. 3 Kempsmith plain milling machine. Tools—Milling fixture, cutters.

Operation 8.—Mill face and top of lug. Machine—No. 5421. Type—No. 3 Kempsmith plain milling machine.

Operation 9.—Mill surplus stock on face. Machine—No. 5410. Type—No. 4 Becker vertical milling machine.

Operation 10.—Drill and ream hinge hole and counterbore. Transformation—Fig. 101. Machine—No. 5714. Type—36-in. Foote-Burt drilling machine. Tools—Boring bars and cutters, counterboring tools, gages.

Operation 11.—Drill, bore and ream rack hole. Transformation—Fig. 102. Machine—Nos. 5712 and 5713. Type—36-in. Foote-Burt drilling machines. Tools—Drilling jigs and fixtures, thread hole plugs, gages, hand pilot-reamers. Coolant—Solution of cutting compound.

Operation 12.—Mill to profile. Rough cut on Pratt & Whitney vertical shaping machine. Finish cut. Machine—Nos. 5454 and 5455. Type—No. 5C Becker vertical milling machines. Tools—Profile gages, cutters.

Operation 13.—Finish mill rack side. Machine—No. 5417. Type—No. 3 Kempsmith plain milling machine. Tools—Milling fixtures, gages, cutters.

Operation 14.—Mill outside of hinge lug. Machine—No. 5445. Type—No. 3 Kempsmith plain milling machine.

Operation 15.—Mill T-slot and dovetail slot. Machine—No. 5453. Type—No. 5C Becker vertical milling machine.

Operation 16.—Mill small slot and flat. Machine—No. 5490. Type—No. 3 Cincinnati plain milling machine. Tools—Special milling fixtures, gages.

Operation 16A.—Mill plunger clearance. Same machine.

Operation 16B.—Mill plunger angle. Machine—No. 5505. Type—No. 10 Pratt & Whitney vertical shaping machine.

Operation 17.—Slot and broach for rack. Same machine.

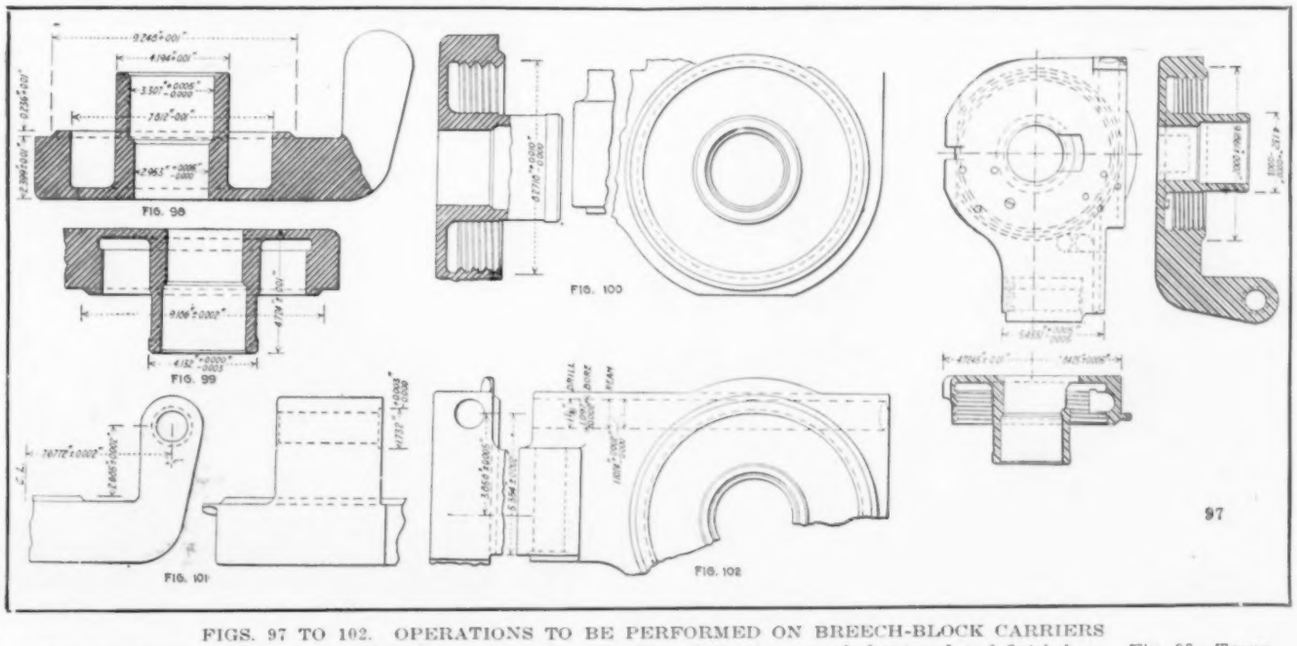
Operation 18.—Drill and tap all holes. Machine—No. 5709. Type—Class L-12 Henry & Wright drilling machine.

Operation 19.—Obsolete.

Operation 20.—Slot angle hole. Machine—No. 5518. Type—No. 10 Pratt & Whitney vertical shaping machine.

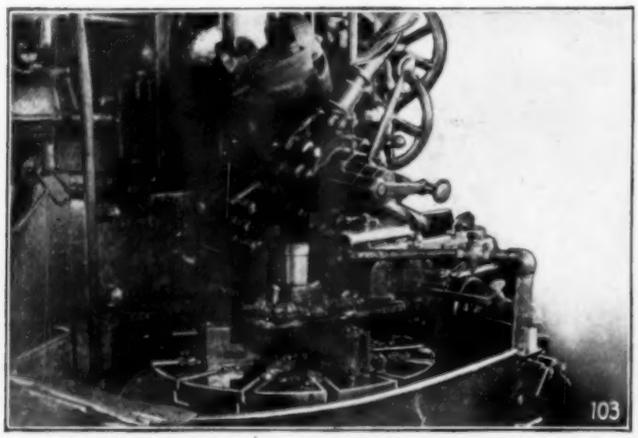
Operation 21.—Mill slot in lug. Machine—No. 5475. Type—Model B Becker vertical milling machine. Tools—Special profile milling fixture.

In order to produce a machined surface suitable for chucking this piece for the succeeding cuts a light cut is taken from the back of the forging in a shaping ma-



FIGS. 97 TO 102. OPERATIONS TO BE PERFORMED ON BREECH-BLOCK CARRIERS

Fig. 97—General outline of breech-block carrier. Fig. 98—Transformation—rough front end and finish bore. Fig. 99—Transformation—finish front face. Fig. 100—Transformation—thread interior of block carrier. Fig. 101—Transformation—drill and ream hinge hole and counterbore. Fig. 102—Transformation—drill, bore and ream rack hole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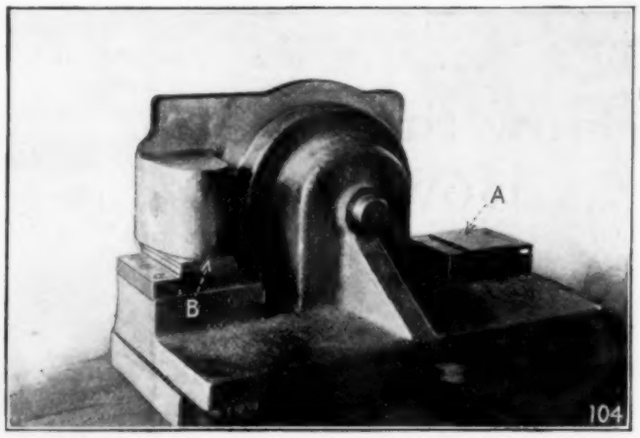

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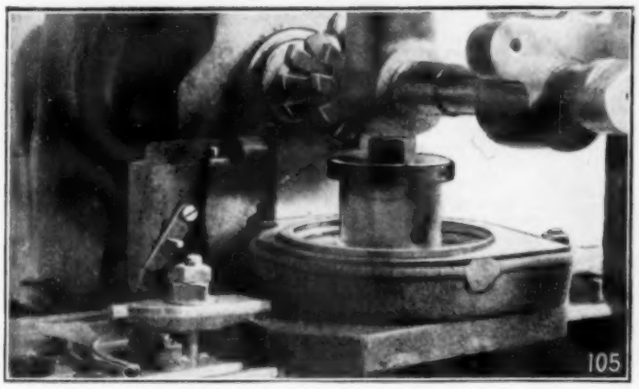
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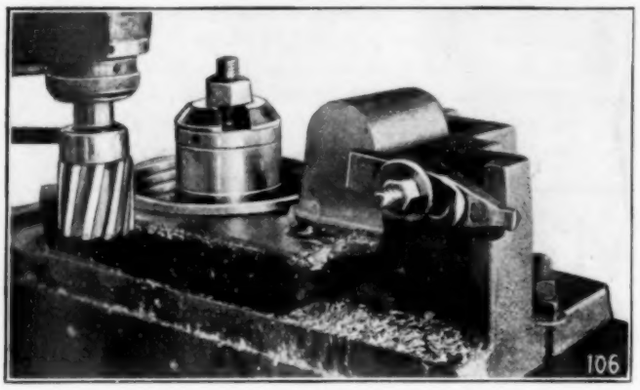
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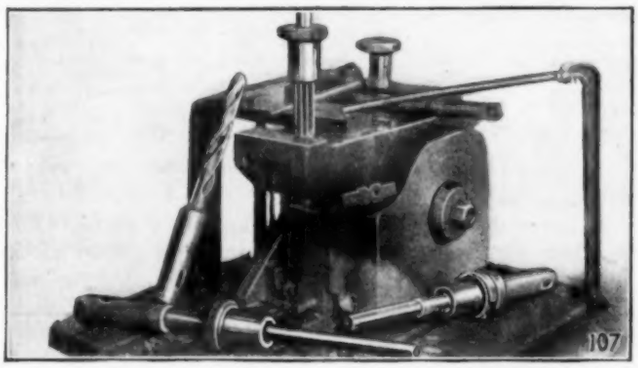
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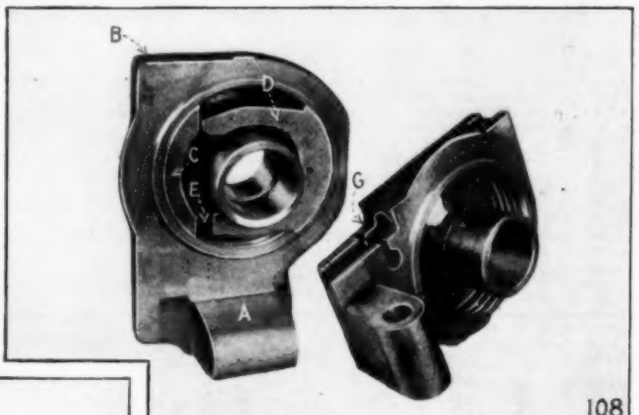

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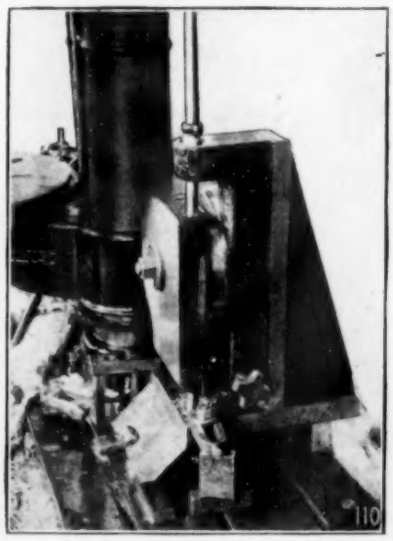
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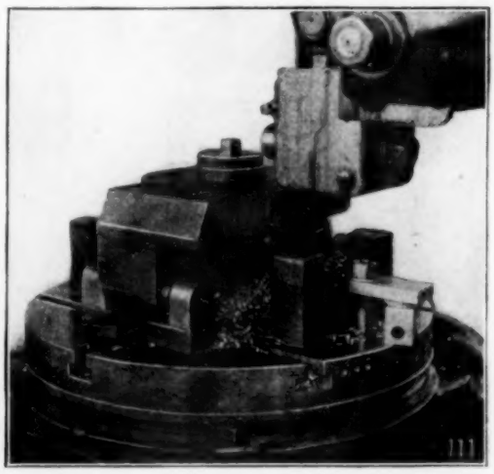
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Fig. 103—Heavy preliminary machining operations on Bullard vertical boring machine. Fig. 104—Scraping jig for true surfaces on sides of hinge lug. Fig. 105—Milling radius surface on end of hinge lug. Fig. 106—Milling away surplus stock on surface. Fig. 107—Drilling and reaming of the hinge hole. Fig. 108—Views of partly and nearly completed block carriers. Fig. 109—Drilling operations on the rack hole. Fig. 110—Jig and tools for reboring and reaming rack hole. Fig. 111—Removing excess stock from edges on vertical shaping machine.

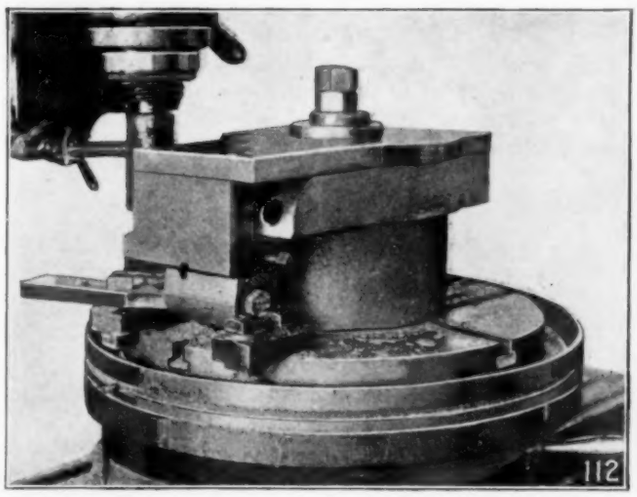


FIG. 112. PROFILING EDGES OF BLOCK CARRIER

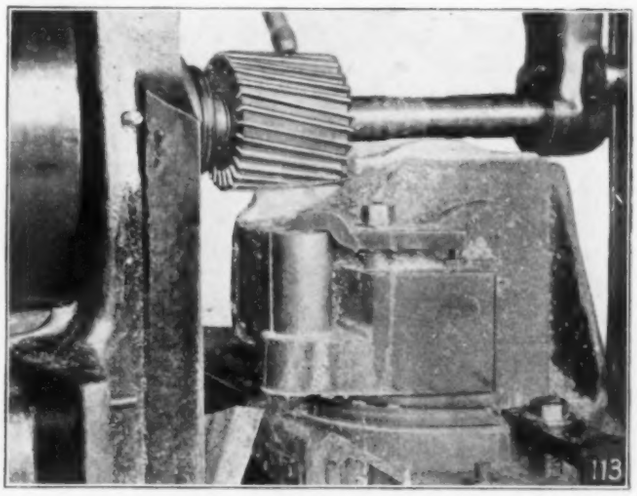


FIG. 113. REMOVAL OF CORNER ADJOINING HINGE LUG

chine. This gives a surface for a firm bearing during the heavy cuts used in operation 2.

The tool setup used in the Bullard vertical turret lathe for the second operation is shown in Fig. 103. During all cuts made in this operation a heavy stream of cutting oil is constantly supplied to the tools.

The roughing cuts on both the lathe and milling-machine operations are followed by lighter cuts until the greater portion of surplus stock has been removed.

After the finish-boring cut in the center and the finish-milling of the hinge lug sides the part is mounted on a special fixture, Fig. 104, and first one side of the hinge lug is scraped to a bearing on the surface plate *A* at the right. Then the piece is rotated about a center bearing, and the opposite side is scraped to a bearing on the surface plate *B*. The thickness of the lug must at the same time be held within the tolerance allowed.

Milling the Radius

Milling the radius on the end of the hinge lug, Fig. 105, is performed with the setup as shown, using a forward milling cutter. The fixture for holding the work has swinging gages for setting the cutters for height similar to those used on the gun body.

Another operation follows in which the faces of the hinge lug are milled. Operation 9 follows this, and consists of milling the surplus stock on the face of the block carrier as shown in Fig. 106.

Drilling and reaming the hinge hole is performed with the use of the drill jigs and drilling and boring bars, which are illustrated in Fig. 107. The position of this hole is within accurately prescribed limits, and the block carrier is centered by a plug which fits the finished inside of the center bore.

Rack-Hole Drilling Operation

A good idea of the appearance of the inside face of this part may be obtained from Fig. 108. The piece *A* at the left is arranged for the rack-hole drilling operation, with the location of the rack hole at the point *B*. As this hole will intersect the threaded recess in the carrier it would be impossible to drill it without supporting the drill at that point. For this purpose the pieces *C* and *D* are inserted. The piece *C* is made up in the form of a circular-threaded ring and suitable sections cut into it with a slitting saw. The U-shaped piece *D* is also threaded where it comes into contact with the surface of the block carrier, and is provided at *E* with a jackscrew to hold both pieces in place.

The type of drill jig used in drilling the rack hole is shown, Fig. 109. With it the work is again centered by the counterbore and the alignment assured by the lug *A*.

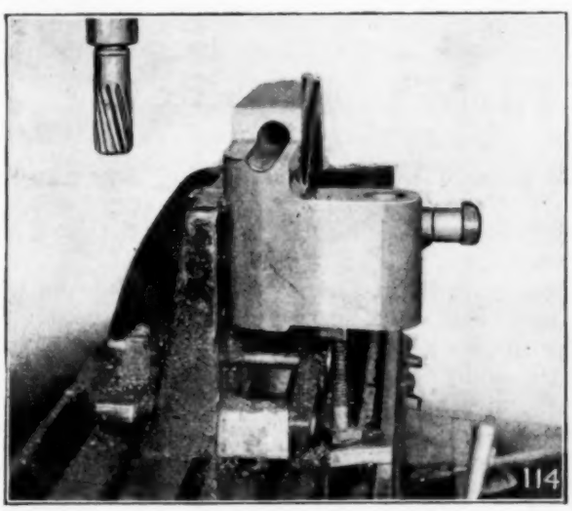


FIG. 114. FINAL MILLING OPERATION BY HINGE LUG

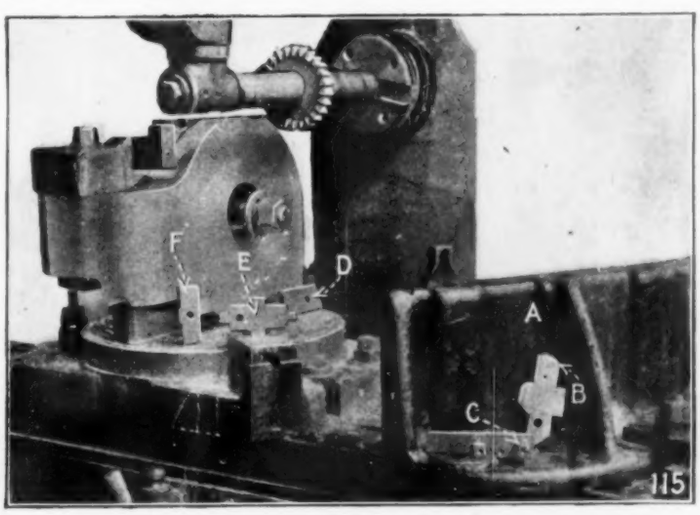


FIG. 115. SETUPS FOR MILLING SLOT AND FLAT

After this hole has been drilled the part is placed in a similar jig, Fig. 110, for reboring and reaming the hole for the different sizes required. A full set of boring bars, reamers and bushings is furnished the operator, who completes the job at this setting, and a large part of the excess stock on the outside of this piece is removed in a vertical shaping machine, as shown in Fig. 111. This is followed by the profile-milling operation illustrated in Fig. 112. A hardened-steel profile gage fits on the back face of the part and a collar above the cutter bears against it when taking the cut. Power feed is used in following the outlines so far as is possible, the remainder of the cut requiring hand feed.

By referring to the right-hand view in Fig. 108 it will be seen that a portion of the corner at *G* has been milled away. The milling operation for the removal of this corner is illustrated in Fig. 113, and it will be noticed from the appearance of the part and fixtures that a very heavy flood of coolant has been used. Another form of milling operation on this same corner is shown in Fig. 114, this latter being the final cut on this section.

Operations 16, 16A and 16B are usually performed on the same machine. The first of these is shown in process in Fig. 115. This same milling fixture is used for the second cut in the series. For the third cut the work is transferred to the fixture mounted on the right of the milling-machine table at *A*. Some of the small gages used in these cuts are shown at *B*, *C*, *D*, *E* and *F*.

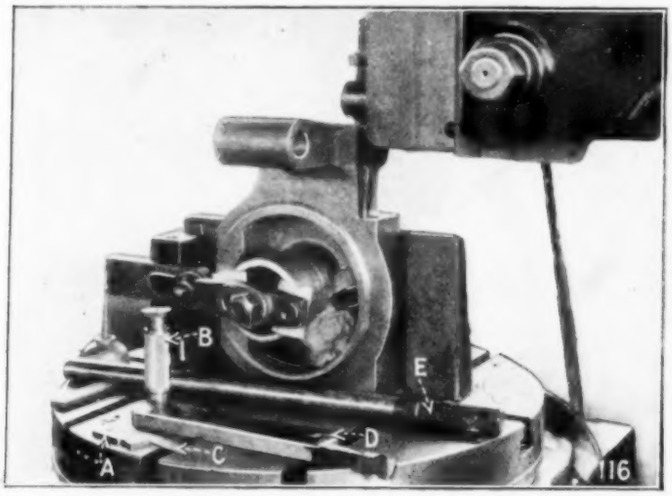


FIG. 116. TOOLS AND FIXTURES CUTTING T-SECTION IN THE RACK HOLE

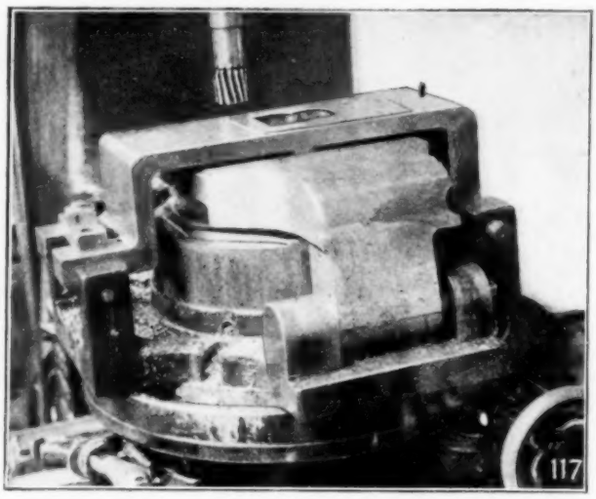


FIG. 117. SPECIAL FIXTURE AND TOOLS FOR MILLING SLOT FOR HOUSING

The cutting of the T-section of the rack hole is illustrated in Fig. 116, which shows the method of setup on a vertical shaping machine. Some of the tools and gages used are shown at *A*, *B*, *C*, *D* and *E*.

Final Milling Operation

The final milling operation on this part will be found illustrated in Fig. 117. The profile guide plate which passes over the back side of the block carrier is hinged at one end, and on the other fits down into a slot in the base casting of the jig when closed down over the work. The methods for aligning the work in this fixture are similar to those employed in the majority of the fixtures previously described.

A thorough inspection concludes the operations on this part, Fig. 118. For this purpose it is mounted on an angle plate, and with suitable gages the inspector checks up between the rack hole, the location of the hinge section and hinge-pin hole, and also of the rack-lock hole.

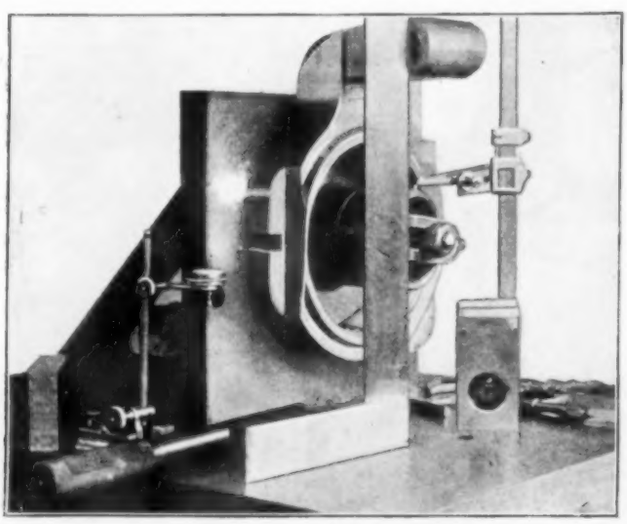


FIG. 118. GENERAL VIEW OF FINAL INSPECTION OPERATIONS AND GAGES

Paraffine for Rust Prevention

By William Hintze

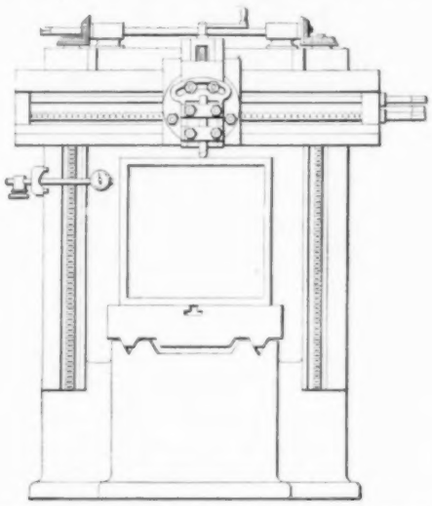
An excellent substitute for vaseline and those greasy and dirty compounds commonly used on bright pieces to prevent rusting when they are exposed to the weather is paraffine.

To prepare it for use take a vessel large enough to cover the articles to be coated and fill it with gasoline. Dissolve in this all the paraffine that it will take up without clouding the solution. Dip the articles in the solution, and hang them up to dry out. The gasoline will evaporate, leaving a thin transparent coating of paraffine which is an efficient rust preventive besides being invisible and free from the stickiness that is a disagreeable factor of other compounds.

Dial Indicator Used in Setting Up Work on Planing Machine

By H. W. McCray

In planing a large piece of work on adjacent sides, especially when the work approaches the capacity of the planing machine, there is little or no room on the table on which to set a master square. By the use of the dial indicator as shown work may be set up very accurately without first taking a roughing and finishing



SQUARING LARGE WORK BY A DIAL INDICATOR

cut. Then when the work is planed it can be tested with a master square, the clamps loosened and the work reset to correct this error.

This is very important if the amount of stock to be removed is limited, and it is also the means of saving a considerable amount of time otherwise wasted.

It might be well to add that preliminary to the use of the indicator as described it is necessary to set the cross-rail square (by indicating a master square set on the housing) and take a cut across the table, otherwise the indicator reading would be valueless.

Elimination of Chatter Marks

By F. W. Bach

On page 349, Vol. 49, of the *American Machinist* an article on eliminating chatter marks has constrained me to add a few examples that have come within my own experience.

In dealing with the chattering of internal-threading tools the author of the article referred to above mentions only their tendency to spring down below their normal position and thus dig into the work. There is also a change in the position of the point of the tool with reference to the longitudinal center of the work,

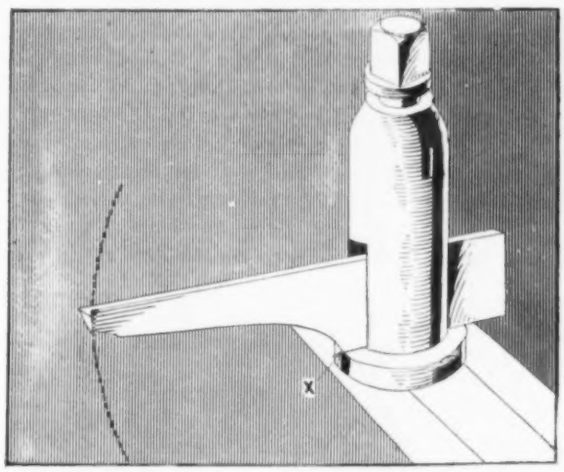


FIG. 1. SPRING OF TOOL IN INTERNAL THREADING

owing to the fact that any movement of the former will take place in the arc of a circle whose center is at *X*, Fig. 1, and thus the tool point will be advanced or retarded as this center is above or below the cutting edge.

The only remedy for this trouble in internal threading seems to be to provide a tool that is rigid enough to withstand the pressure of the cut, but it has been provided against to some extent in external work by the goose-neck form of tool, examples being shown at *A* and *B*, Fig. 2, in which the tool point recedes from

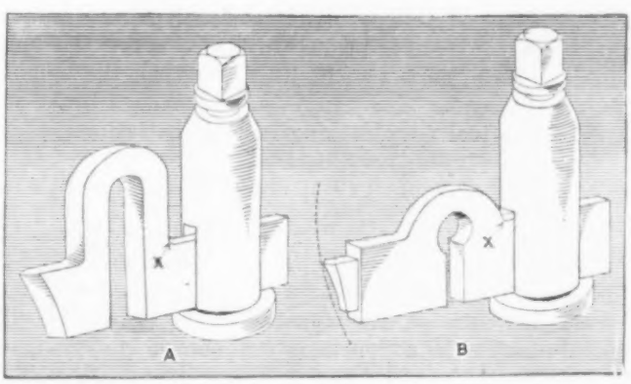


FIG. 2. GOOSE-NECK FORMS OF THREADING TOOL

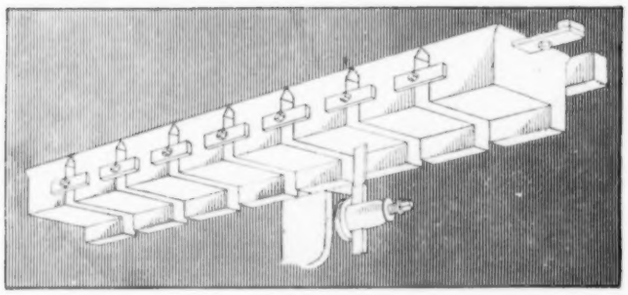


FIG. 3. WORK SPOILED BY SPRINGING TOOL

the work under extra pressure instead of turning about the center X as in the rigid form.

An example of chatter and scoring with the straight form of tool is shown in Fig. 3, where a string of cast-iron blocks is shown upon the table of a planing machine, the work being done with a common parting tool with a blade $\frac{1}{4}$ in. wide.

When about half way across the tool dug in, causing a bad score in three of the blocks. On examination a small piece of metal was found to be "seized" or welded upon the face of the tool and we figured that the spring of the latter had allowed the face, which had only a very slight clearance, to drag, and had generated sufficient heat to weld on the "bug" and spoil the work.

A parting, or cutting-off, tool used in a lathe is a prolific source of chatter, which can be avoided to a con-

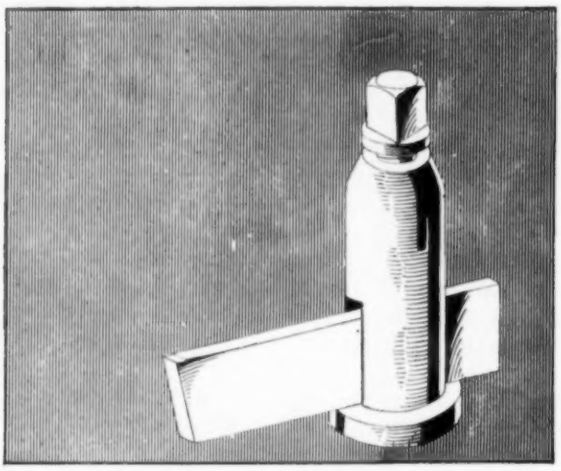


FIG. 4. SQUARE-NOSED PARTING TOOL FOR LATHE

siderable extent by using the goose-neck tool shown in Fig. 2. Such a tool is however not always available, and as a partial remedy or prevention I grind a lip on the ordinary straight-bladed tool and make the end almost square, as shown in Fig. 4. When the tool is set on the center this square nose acts as a brake to prevent the tool from digging in and chattering.

Automatic Ejector for Flat Blanks

BY C. W. HINMAN

When flat blanks are to be perforated and the old method of making the nest for the blank is followed, the pieces will stick after perforating, or if not pieces will remain under the stripper plate whence it is difficult to get them out.

We have entirely eliminated this trouble in two ways. One way is shown Fig. 1. The punches lift the work up to the stripper plate when the punch ascends, and at the same time forces back the angle-faced spring plunger. When the punches strip out the spring plunger automatically ejects the work in front of the die.

In loading this tool the operator simply pushes back

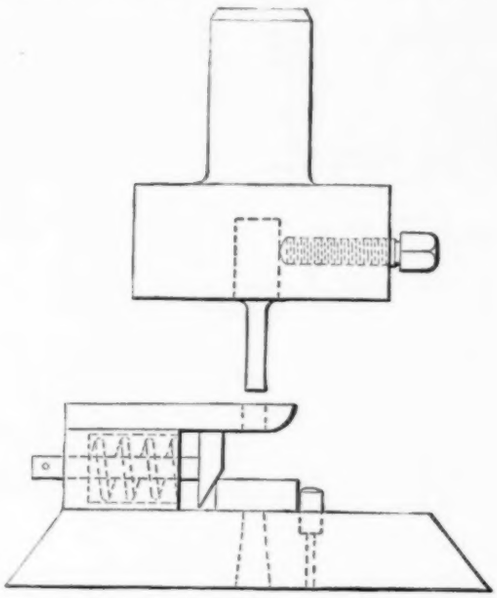


FIG. 1. PIERCING TOOLS WITH AUTOMATIC EJECTOR

the spring plunger with the next blank and snaps the blank between the spring plunger and suitable stop pins.

In the other method shown in Fig. 2, the stripper plate is lifted high, out of the way of the operator's hand, by four coiled springs, so that the blank to be perforated can easily be placed in a nest in the die. When

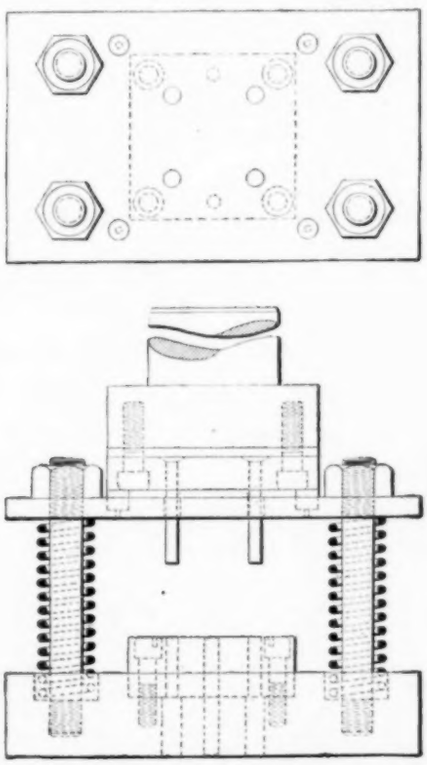


FIG. 2. SPRING-ACTUATED STRIPPER ON PIERCING TOOLS

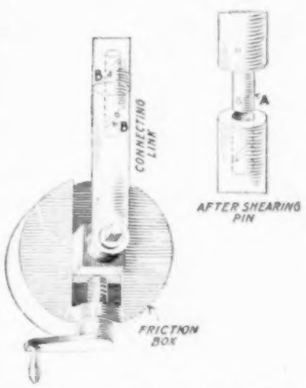
the punch descends the stripper plate is carried down with it and, after perforating, the blank is stripped off when the stripper is high up away from the die.

The perforated blank falls down on the face of the die and can quickly be pushed away when the operator places the next blank.

A Safety Device for Feed Mechanisms On Planing Machines

BY J. H. SPOOR

The following is a rather interesting example of how a mechanism can be made to break at a predetermined place where repairs can be made quickly. The feed mechanism on the planing machine had been broken several times by careless operators who would feed the vertical slide down to the limit of its travel and then some.



SAFETY DEVICE FOR FEEDS OF PLANING MACHINE

After noting that the regular down feed put the connecting link under tension the repair as illustrated was decided upon. The link, or rod, was cut in two and the pin *A* centrally located in each part, being held in place by the small pins *B*, the size of which was determined by experimenting with pins each slightly larger than the preceding pin, until one was found which would stand all the general operating stresses but would shear before causing some other part to break. About $\frac{3}{32}$ in. was found to be the right size for this purpose.

As this planing machine was doing service in breaking in men who had never operated such tools before, the need for a device of this kind is apparent. Upon the breaking of the pin the operator would at once have a lesson impressed upon him as to the possibilities of trouble inherent in positive mechanism which has a fixed limit to its movement. The link could then be taken to the toolroom, repairs quickly made and the machine put back into operation.

Using Up Stellite Scrap

BY T. PILKINGTON

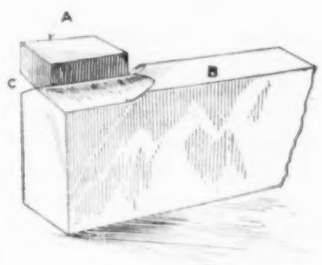
In view of the interest in the use of Stellite shown by recent articles in the *American Machinist* a few words calling attention to methods used for the disposal of its scrap may be useful. The following is the result of experience in England with Stellite used for finish-turning 6-in., 8-in. and 9-in. high-explosive shells of forged steel containing on an average 0.6 per cent. carbon. The shells had been rough-turned so as to leave material for a finishing cut 0.023 in. in depth; the feed was 3.25 in. per minute on the 6-in. shells and the cutitng speed 208 ft. per minute, Stellite of grade No. 2 being used.

The Stellite came to hand in $\frac{1}{2}$-in. square bars, each bar approximately 12 in. long and averaging 1 lb. in weight. The bars were cut by means of a $\frac{3}{32}$-in. thick abrasive wheel into lengths suitable for the toolholders; that is, about 3 in. long. The cut was taken at an angle about equal to the tool-clearance angle in order to save material and grinding labor. The 3-in. lengths were used until too short for the toolholders, that is, until each was about 1 in. in length. They were then collected and returned to the Stellite manufacturers, who allowed 75c. per pound for this scrap. As the price charged for new Stellite at that time was $5 per pound, some method whereby such scrap could be employed to better advantage appeared desirable.

The short tips of Stellite were arc-welded to machine-steel shanks. *A* is the Stellite and B the shank. The clearance at *C* was ground to facilitate arc-welding and was filled up during the welding process by the welding wire.

The resulting tools appeared sound and good in every respect, but upon being put to work the wearing qualities of the Stellite were found to be very inferior, and after a few trials of the welding process it became evident that a radical change should be made as the metal tip was decidedly softer after the welding.

Recasting the scrap into $\frac{1}{2}$-in. square by 12-in. bars was therefore tried and with success. An electric furnace was used for reducing the scrap, and vertical iron molds faced with lampblack and of sufficient bulk to form an effective chill were employed. The molds were warmed before the pouring. To the scrap Stellite was added 2½ per cent. of ferrouranium containing 35 per cent. uranium—some of this latter slags off, however—and the charge was protected from the atmosphere of the room. Uranium in the above proportion appears to refine the grain and consolidate the resulting cast, rendering it free from blowholes. The resulting Stellite gave 650 Brinell hardness, and upon test a ½-in. square sample, held in an Armstrong toolholder, finish-turned 25 to 83 of the 6-in. shells per grinding of the tool as compared with 19 to 33 shells per grinding obtained from a similar tool working under similar conditions of feed, speed and work but made from material supplied direct by the manufacturers as No. 2 grade.



USING UP STELLITE SCRAP

When grinding Stellite tools it is well to remove as little of the surface metal as possible since the hardest and best metal will be found near the surface.

A Convenient Indexing Dial

BY J. H. BODENSTEDT

We ran up against a job where we had to graduate a dial with 125 divisions and there were no dial plates that would make 125 equal divisions.

We would have had to use a 39 plate and move 13 holes, but that would only give 120. Then it would be up to differential gearing and we could not find gears, so I had the machinist make a new dial with 25 divisions, which by moving eight holes would give me the required 125 divisions.

U.S. ARMY ORDNANCE NEWS

The discharge of officers in the Ordnance Department continues to be rapid. The present rate is between 200 and 250 a week.

* * *

Capt. A. K. Howell, who is interested in the Bonsack Machinery Co., St. Louis, Mo., has left the service after 16 months' service.

* * *

Capt. Ward A. Miller of Pittsburgh, Penn., who was employed by Joseph T. Ryerson & Son, Chicago, Ill., has left the service.

* * *

First Lieut. Walter R. Mitchell, lately discharged, was formerly with the Crane company, Baltimore, Md., as mechanical engineer.

* * *

Capt. Arthur F. Hebard, discharged Jan. 31, was in the New York office of the Remington Arms Co. before entering the service a year ago.

* * *

Maj. Carroll H. Gardner of Yonkers, N. Y., who has left the service, was formerly with the American International Corporation in New York.

* * *

First Lieut. Martin L. Millspaugh, who was with the Mills & Millspaugh Co., Columbus, Ohio, construction engineer, was discharged on Jan. 31.

* * *

Capt. W. W. Chapin of Montclair, N. J., has been discharged. He was with Thomas Hastings, New York, as structural engineer on heavy construction.

* * *

First Lieut. Paul W. Gaebelein, lately discharged, was previously employed by Benjamin B. Lawrence, 60 Wall St., New York. He is a metallurgical engineer.

* * *

Maj. Rodney D. Day of Pittsburgh, Penn., has left the service. He was with the Mesta Machine Co. of that city before being commissioned in December, 1917.

* * *

Second Lieut. William B. Spooner, Jr., recently discharged, was formerly with the Primos Chemical Co., Primos, Penn., and while in the Ordnance Department was on duty in the Nitrate Division.

* * *

Second Lieut. Frederick C. Birmell, who was recently discharged, entered the service as an enlisted man in September, 1917. He is a chemical engineer and served with the Nitrate Division at Sheffield, Ala.

Lieut.-Col. Merrill G. Baker of New York has been discharged. He entered the department in July, 1917, and was twice promoted. In civil life he was in the steel industry as sales and distribution manager.

* * *

Second Lieut. Paul L. Keachie, who has been at Rock Island Arsenal, was discharged recently. In civil life he is a mechanical engineer and was employed by the Arnold company, Chicago, Ill., on plant construction.

* * *

Two officers whose homes are in Pittsburgh, Penn., were in the list discharged Jan. 31. They are Capt. Harry W. Eisenhart, formerly with the Frick & Lindsay Co. as a steel salesman, and Capt. Ralph R. Lally, former district sales agent of the National Tube Co.

* * *

First Lieuts. William B. Huntley of Syracuse, N. Y., who was formerly connected with the Crucible Steel Co., and Edward F. Keating of the E. F. Keating Co., New York, were discharged on Jan. 30. Both have acted as negotiators in the purchase of steel for the department.

* * *

Three specialists in shop management recently discharged are First Lieut. Edward R. Kent, formerly with the Celluloid Co., Newark, N. J.; First Lieut. William E. Curley with Thompson & Lichtner, Boston, Mass., and Second Lieut. Walter E. Lott, with the Regina Co., Rahway, N. J.

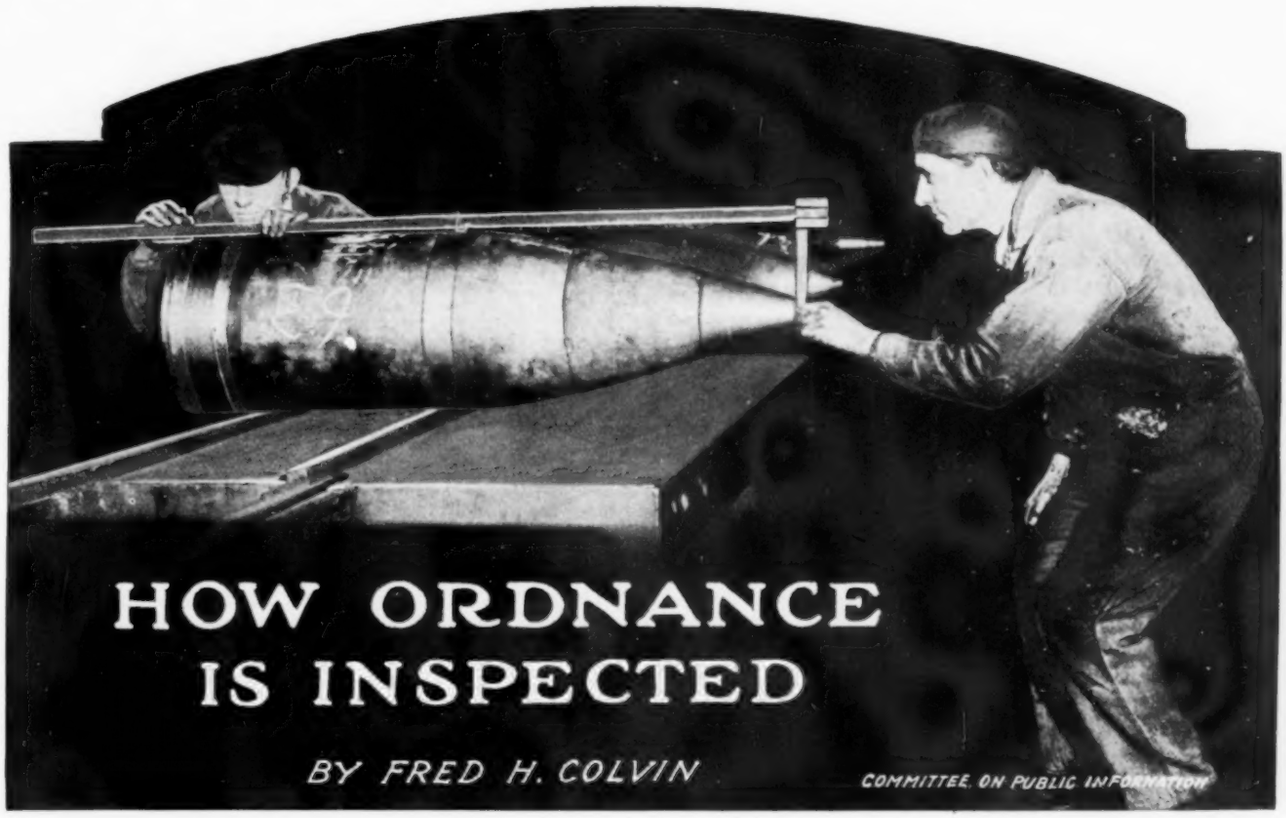
* * *

Among the New York men who have left the service are Capt. Lew E. Wallace, formerly a salesman for the Youngstown Sheet and Tube Co.; Capt. Worthington Campbell, a patent lawyer with W. A. Redding, 38 Park Row, and First Lieut. Cecil McC. Billings, mechanical engineer, formerly with J. M. Lansden, 1790 Broadway.

* * *

Capt. George A. Wills of 1067 Madison Ave., New York, was recently discharged. He has been with the Motor Instruction Schools since entering the service, first as student and later as instructor, devoting his time especially to preparation of technical textbooks. In civil life he was a consulting engineer employed by the Adams Express Co. and others on work in connection with purchase, maintenance and operation of motor equipment. It is understood that he is undecided as to his future connections.

[*Continued on page 316*]



II. Work of the Small Arms Group

This article shows the work done by the Small Arms Group, including rifles and rifle ammunition and artillery ammunition. Few realize how these groups run up into quantity production. The schedule for the service-rifle cartridge, for example, called for nearly two billion during the last six months of 1918, and almost double this amount for the succeeding six months.

THE Small Arms Group has been responsible for the results obtained in the production and inspection of all machine guns of all types, automatic rifles, magazine rifles, pistols, revolvers, tripods, etc., including all accessories, appendages, spare parts and base spare parts for each type of arm. Machine guns of the various models are divided into three different types, i.e., mobile, aircraft and tank. Each type has its individual peculiarities adapting it to the purpose for which intended.

In order to attain the greatest degree of interchange of components between plants the enormous quantity of gages required both by the contractor and the Inspection Division taxed the capacity of all contractors' plants as well as all available outside capacity. It was imperatively essential that the contractors first provide the plants with sufficient gages to start production, the inspection gages being a secondary consideration, consequently no inspection gages were available in the early stages of production. Until the necessary gages were furnished, the inspection was controlled by the presence of a supervising inspector or inspectors being placed at each of the contractor's inspection stations throughout the plant, whose duty it was to observe the gaging of all critical operations and frequently apply the gages personally. It is due to this careful watchfulness that a satisfactory degree of interchangeability of product between plants was obtained, considering the great pressure under which the development and subsequent production was obtained. The difficulty encountered in mass production can only be appreciated when the progress made and the rapidity with which development progressed, coupled with the great lack of skilled workmen wherein inspectors had to be taught, are considered. Female inspectors became a necessity, and through their aptness they have established themselves as permanent inspectors for certain classes of production in the manufacture of small arms. Despite all the obstacles encountered, a percentage varying from 85 to 98.7 per cent. of interchangeability between plants was accomplished from the beginning.

The contractor is responsible for the correctness of the product when it leaves the machines, whence it is then routed to a near-by inspection station where the contractor's inspectors carefully inspect each component either 100 per cent. or less, governed by the accuracy to which the components have been machined and dependent upon the importance of the component relative to the proper safety, functioning and interchangeability required. Such components as pass this inspection are then routed to the finishing departments where they are then filed, burred, cornered and polished, after which they are routed to the Government inspection force where they are given a similar inspection as above described on a percentage basis. While this will at once be called double inspection the rejections made by the Government vary from 0 to 100 per cent.

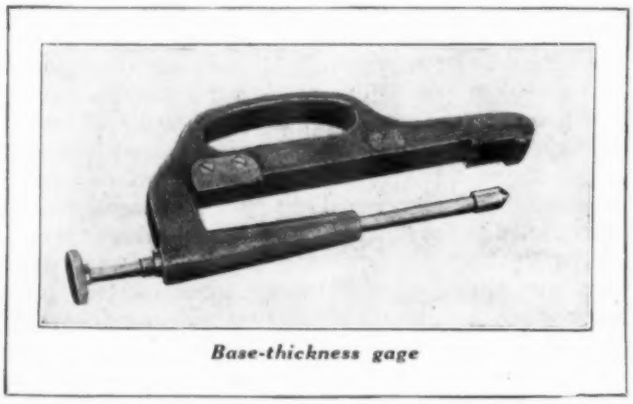
It is due to this careful inspection, however, that a very satisfactory degree of interchangeability was attained, as quoted before and a great quantity of irregular components eliminated from the product, which would otherwise be assembled in arms, that would also affect the assembly output per man. This is organized as a "group inspection" on the larger and more complicated components requiring several gagings which pass through a series of inspectors, the last inspector placing a final inspector's acceptance stamp upon the component, vouching for the correctness of the remainder of the group inspection.

Each inspector's stamp contains a serial number assigned and recorded against the individual inspector. Should the inspector sever his connections with the service the stamp is taken up and not reissued in the same plant, so that any errors existing can be readily traced to the individual inspector responsible. The rejected parts are passed to a Government salvage department where extreme tolerances are applied, and such as are acceptable are stamped by the salvage inspector.

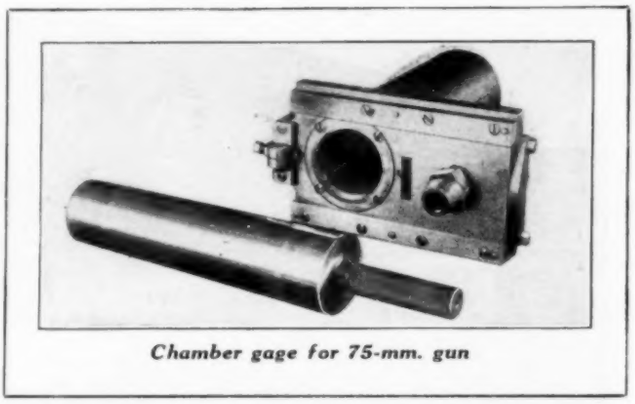
How the Work Is Progressed

The product after passing through the first, or white-stage (untreated), inspection is again routed to the contractor, where it is given the prescribed heat treatment. This includes hardening and tempering or rust-proofing finishes, such as browning, niter-bluing or machine-bluing. When completed, the product is again routed to the Government inspection force for final component inspection (black stage). This inspection is largely visual, inasmuch as the principal gaging points are more or less distorted due to the heat treatment above described. Many of the vital points, however, are subjected to further gaging, as for example the bores and chambers of barrels are examined for straightness and accuracy. The bolt holes in the receivers are tested for size and straightness. The bolts are carefully gaged for size, concentricity, position of locking shoulders, striker-point hole, etc. Such components as are found to be satisfactory are then routed to the finished-stores department, where they are issued to the contractor for the necessary group or final assembly into finished arms, when they are again routed to the Government inspection department for final inspection, proof-firing, targeting, packing and shipping.

The rifle is such a well-known arm that a little data as to its inspection will show something of the enormous task before the inspection division in handling over 10,000 completed rifles a day, with enough spare parts to make up perhaps 2000 more. The largest plant was that of the Midvale Steel and Ordnance Co., with its rifle plant at Eddystone, Penn., as this plant made something over 50 per cent. of the total output of the country, or between 5000 and 6000 completed rifles a day, with spare parts in addition. And realizing that this was a new plant and that very few of the organization were familiar with rifle manufacture, it deserves great credit.



Base-thickness gage



Chamber gage for 75-mm. gun

The company made the 1917 model, which has something over 100 component parts and weighs about 9¾ lb., complete, so that over 50,000 lb., or 25 tons, of finished product was handled every 24 hours.

There are 1660 operations on the rifle, of which 927 are inspected operations, and these require 1897 different kinds of gages. There were 15,826 gages in use daily by the inspectors of the company, while the Army inspectors used 527 different kinds of gages, 50 of which were not used by the company at all. The Army inspectors numbered about 1300 in this plant, while the company employed 1500, or 10 per cent. of the force.

Allowing for rejects and for recuts, or pieces which had to be returned for correction, there were something over 15,000,000 operations a day which had to be inspected, or about 1000 per employee.

With nearly every piece the inspection was 100 per cent., but they hold the record for rapid assembling of rifles—194 complete rifles in 5 hours by one man.

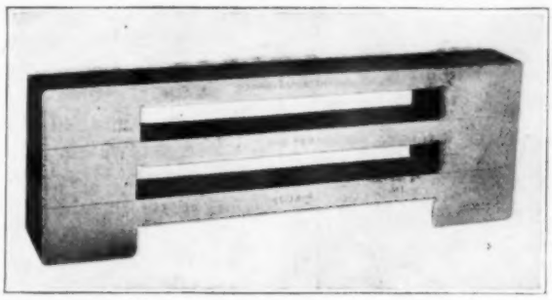
The following records of some of the principal items will give some impression of the volume of finished arms inspected and accepted since the war began to and including Dec. 7, 1918:

MACHINE GUNS, RIFLES, PISTOLS, ETC., INSPECTED

Weekly Production of Finished Arms	Inspectors	Operations Inspected	Number of Gages Used
57,584	3,000	10,708	13,405

SUMMARY OF ARMS INSPECTED TO DEC. 7, 1918

Type:	Inspected and Accepted
U. S. rifles, caliber 0.30, model 1917	2,341,732
U. S. rifles, caliber 0.30, model 1903	343,949
Ross rifles	20,000
Russian rifles	280,049
Pistols, caliber 0.45, model 1911 (Colt and Remington, Bridgeport)	417,275
Revolvers, caliber 0.45, model 1917 (Colt and Smith & Wesson)	289,211
Browning machine guns, model 1917	50,661
Browning automatic rifles, model 1918	61,712
Vickers' machine guns, model 1915	15,239
Colt's machine guns	2,500
Marlin aircraft machine guns, model 1917	38,545
Marlin tank guns	490
Browning aviation	133
Lewis machine guns, model 1917	52,342
Tripods, all types, (11/21/18)	25,085
Bayonets, model 1917 (11/21/18)	638,107
Bolos, models 1910 and 1917 (11/21/18)	129,771
Sabers, model 1913	28,767
Gunstock blanks, models 1903 and 1917 (11/21/18)	5,476,378
Hand guards, models 1903 and 1917 (11/21/18)	1,487,349



Diaphragm

From the above record it will be noted that the total rifles of all types inspected is 3,048,442 and does not include the United States rifles, caliber 0.30, model 1903, manufactured prior to the declaration of war. The next larger item is the total machine guns inspected, 219,093. While the former figures are believed to be unequaled the latter is considered fully as great an achievement, due to the adoption of the several new types and the consequent later development and organization for their mass production.

Small-Arms Ammunition

Prior to 1917 the regular 0.30-caliber service and 0.45-caliber pistol cartridges developed at our ammunition factories were acknowledged to have no superiors among the military ammunition of the warring nations. On the declaration of hostilities with Germany and her allies the experts from our regular army establishment and reserve officers from the technical field were organized into the Small Arms Division under Col. John T. Thompson (now Brigadier General) to develop and produce small arms and small-arms ammunition in hitherto unheard of quantities.

THE SCHEDULE OF PRODUCTION

	Last Six Months of 1918	First Six Months of 1919
Service 0.30 caliber	1,775,000,000	3,300,000,000
Tracer	90,000,000	107,000,000
Incendiary	70,000,000	80,000,000
Armor piercing	120,000,000	145,000,000
0.45 pistol ball cartridge	700,000,000	1,000,000,000

With some changes in order that the standard ammunition would be adaptable to the many types of machine guns in use in our army in this quantity production, a quality even superior to that of peace times has been reached. A great deal of attention was devoted to our sources of raw material and existing stocks of metals and chemicals. During peace times it was customary to send broadcast over the world for materials of the highest quality. For instance, two rare chemicals which are used by most manufacturers of ammunition and which were obtained from foreign sources are antimony sulphide and potassium chlorate. In the case of the former it was feared we faced a serious shortage. In the case of the latter the purity of that from available sources was questioned. It became necessary to develop substitutes which would function as well or to refine the available raw material. Such problems as these and the supplies of copper, zinc, lead, antimony, nickel and tin, with the many metallurgical problems arising from their use, require the attention of a large corps of engineers and metallurgists.

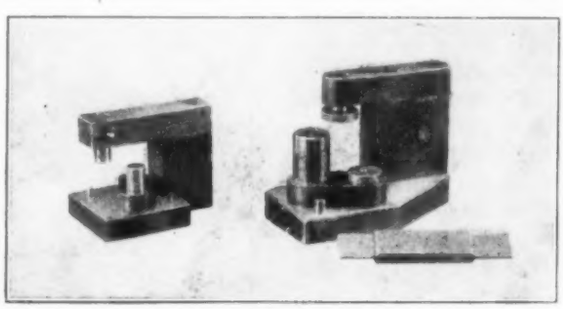
During the refinement and development of the 0.30-caliber service cartridge and getting into a war-time stride of production of this type, special types which have been developed abroad for aircraft and antiaircraft use were pressing for the attention of the engineering experts. Officers were sent overseas to familiarize themselves with their manufacture and design. Here was a new field, for the small 0.30-caliber bullet was called upon to hold within itself until discharged from the gun incendiary materials and diamond-hard armor-piercing cores. As the weight and form of the bullet have a great bearing on the distance and velocity of its flight careful adjustments were necessary on the complicated special types in order that the same setting of the sights on the rifles and machine guns can be used interchangeably for all types.

Machine Gun Feed Mechanism

The feed mechanism of the modern machine gun is carefully devised to operate with a cartridge and bullet of an exact form. If this form is not carefully controlled the feed mechanism will fail to operate. Few people realize that the modern type of machine gun will discharge bullets at the rate of 700 to 800 a minute. This high rate of fire requires ammunition of exact form and size as well as highest quality of material and mechanical workmanship. The Government arsenals and private plants have been brought up to high production of these special airplane types of small-arms ammunition.

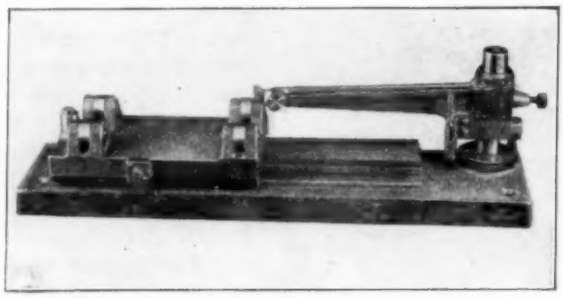
Cartridge Inspection Delicate

The inspection of the finished cartridge presented one of the greatest difficulties. In the increased production it is very necessary to have experts whose sole duty is to determine the quality of the finished product. In spite of the coöperation of manufacturers and skilled mechanics at the plants slight variations from the tolerances will occur and will, if overlooked, cause malfunctions of the rifles or machine guns. A malfunction is particularly serious, as it has a direct effect upon the morale of the men in the field. During the inspection of the small-arms ammunition every cartridge is gaged to determine whether it will enter the rifle chamber. Quantities of cartridges from each manufactured lot are fired to determine the accuracy and to verify the quality and weight of powder charge and infallibility of the primer cap. In the case of special airplane ammunition the bullets are made the object of special functioning tests to determine their action on armor plate and inflammable parts of airplanes.



Fuse-socket holder

Perhaps one of the latest developments in testing small-arms ammunition is the machine called the hang-fire tester. A hang-fire is usually the result of improper mixing of the chemicals, the use of impure chemicals or some mechanical defect of the primer cap, causing slow burning and slow propagation of heat to the powder charge. The primer cap is in truth the very heart of the cartridge. Minute quantities of intimately mixed chemicals go to make up this small but important component. As the machine gun is mounted on the airplane immediately behind and synchronized with the propeller in a manner to allow each shot to be fired between the revolving blades a delay in the explosion of the powder charge might shatter the blades of the propeller and result in the death of the aviator. The hang-fire testing machine is so devised that a revolving disk geared to the machine gun will measure the deviation by angle or time of any shot lagging behind the group of the test lot.

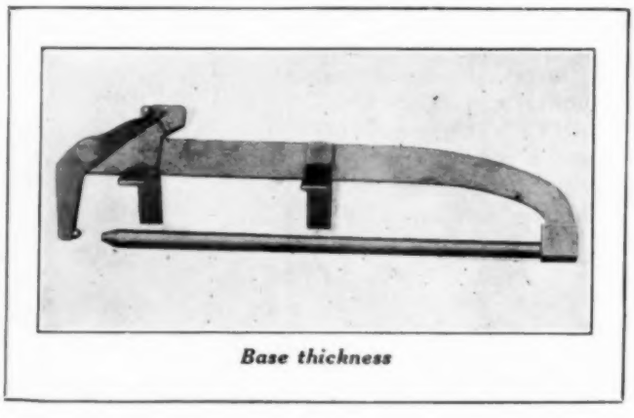


Eccentricity of shells

Artillery Ammunition

Next to small-arms ammunition artillery ammunition runs up into the largest quantities, and so far as tonnage is concerned it far exceeds anything else. Some idea of the amount of this may be had from the fact that the program of 75-mm. shells called for 7,000,000 a month and of the 155-mm. shells about 1,000,000 a month. One of the fears was that the French shells would all have to be hydraulically tested and we did not have either a sufficient number of hydraulic testing machines or the capacity for building them at a sufficiently rapid rate.

The physical properties of the French shells necessitated heat treatment, and the French practice was to water-quench all shells by a spraying system wherein a spray is used both inside and outside the shell. This is a very drastic treatment, and it was feared by some that it would cause cracks, which in turn might be responsible for premature explosion in the gun with its consequent damage, and in too many cases the death of the gun crew. It is stated that during the late summer and fall of 1914 the French lost over 500 guns on account of premature explosion. It is also stated that in small-sized ammunition the French have one "premature" in every 35,000 shots, while the British have but one premature out of every 300,000 shots. This difference is attributed to two causes, one the difference in the type of fuse, and the other to the fact that the shells are not heat-treated. The heat treatment, however, gives superior fragmentation, which makes the shells more effective, and all of our shells are heat-treated but are quenched in oil instead of water. Just to give some idea of the work involved in shell inspection, we show a page of gages used together with other tests which have to be made. The list at the bottom explains each operation and also gives the sequence. When we realize that this inspection must be carried out on over 120,000 shells a day, the size of the task confronting inspectors becomes more apparent.



Base thickness

Among the interesting data which have been collected as a result of the munition contracts are those relating to the life of gages used in the different work. These, as would be expected, vary greatly, both on account of the kind of gage and the use to which it is submitted, together with the effect of the way in which it is used. A nose plug gage for the 155-mm. shell averages 35,000 shells before wearing to the point of being rejected. The gage for the bourrelet and driving bands lasted for 155,000 shells.

Shell rejections for all causes, including the shells wasted in setting up the tools in the machine, average about eight-tenths of 1 per cent., although in some instances it goes as high as 2 to 3 per cent.

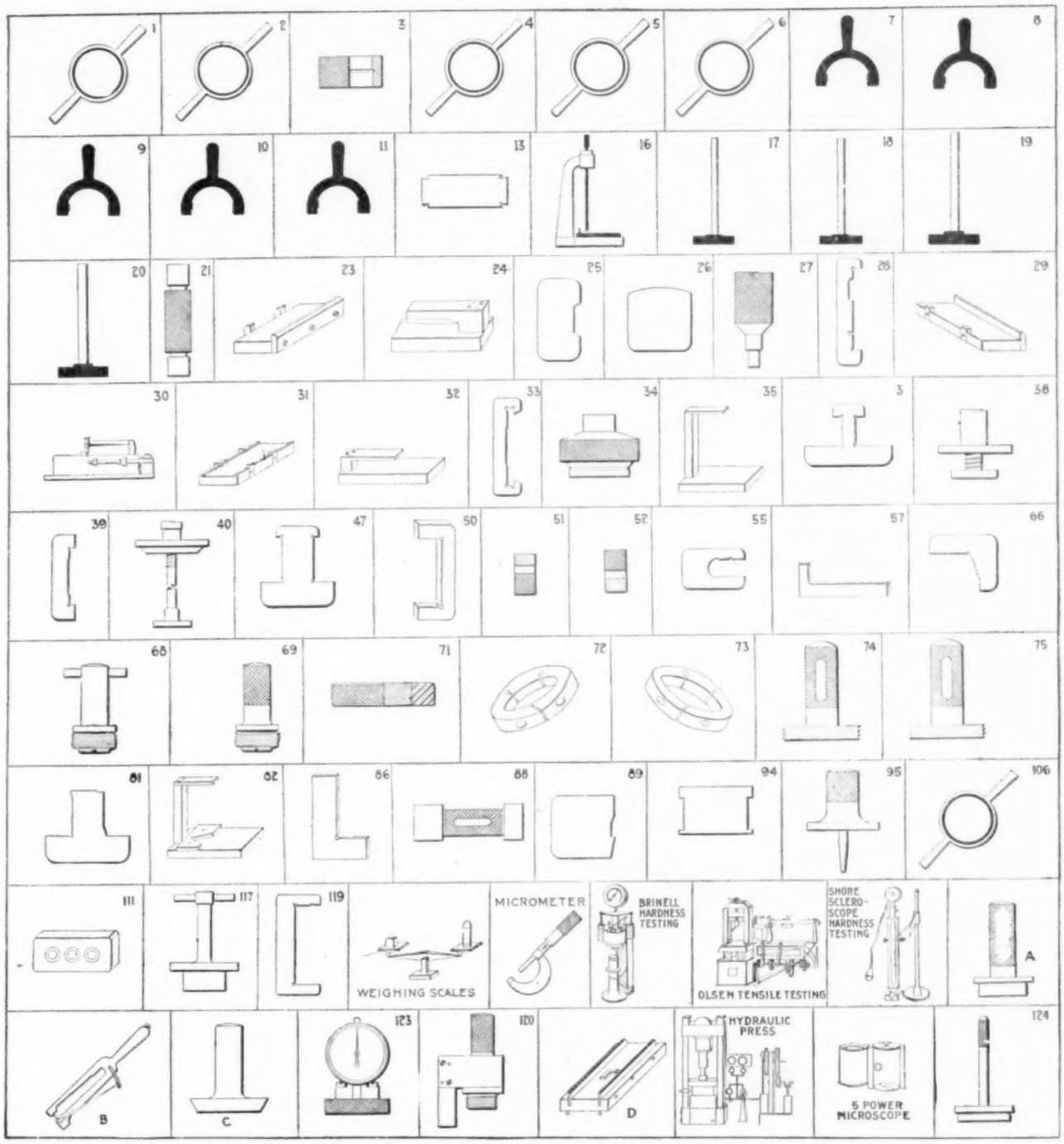
The daily production as of Nov. 1, 1918, is here shown:

SHELL PRODUCTION AS OF NOV. 1, 1918

Type of Shell	Daily Production	Weight in Lb. of Forgings Used
75-mm. high-explosive shell	122,000	2,562,000
75-mm. shrapnel	35,000	560,000
4.7-in. high-explosive shell	9,200	641,200
5-in. high-explosive shell	1,500	126,000
6-in. high-explosive shell	2,500	380,000
155-mm. high-explosive shell	25,828	4,313,276
8-in. high-explosive shell	3,200	1,020,800
9.2-in. high-explosive shell	2,800	1,087,800
240-mm. high-explosive shell	800	520,000
10-in. high-explosive shell	800	552,000
12-in. high-explosive shell	73	97,236
155-mm. shrapnel	2,500	229,750
		12,090,062

The importance of careful and accurate inspection is outlined herewith:

Any piping in the base of the shell may allow hot gases from the gun chamber to ignite the explosive in the shell, often resulting in the destruction of the gun and killing of the gun crew. Base covers are applied to the shell to minimize this danger, but should they be insecurely attached the hot gases may penetrate the base of the shell. Should base covers become detached from the shell during flight there will be serious danger to any troops in the vicinity, as these covers have a sharp edge and travel at a tremendous speed. This danger would be particularly grave in



Gages Used by U. S. Inspectors—75-Mm. Shrapnel

Gage Number	Description
1	Ring Gage, Diameter of Bourrelet, Go
2	Ring Gage, Diameter of Bourrelet, No Go
3	Ring Gage, Concentricity, Band, Go, with rear of Band, No. Go
4	Ring Gage, Diameter of Driving Band, No Go
5	Ring Gage, Diameter of Rear of Band, Go
6	Ring Gage, Diameter of Rear of Band, No Go
7	Snap Gage for Diameter of Body, Go and No Go
8	Snap Gage for Diameter of Bourrelet, Go and No Go
9	Snap Gage for Diameter of Driving Band, Go and No Go
10	Snap Gage for Diameter of Rear of Band, Go and No Go
11	Snap Gage for Diameter of Band Seat, Go and No Go
13	Width of Band Seat, Go and No Go
16	Gage for Thickness of Base
17	Plug Gage for Diameter of Powder Chamber, No Go
18	Plug Gage for Diameter of Powder Chamber, Go
19	Plug Gage for Diameter of Diaphragm Seat, No Go
20	Plug Gage for Diameter of Diaphragm Seat, Go
21	Double end pluggage for counterbored hole in Diaphragm
23	Slide Gage for Diameter of Diaphragm, Go and No Go
24	Snap Gage for Height of Diaphragm, Go and No Go
25	Profile of Tube Support Diaphragm
26	Profile Bottom Radius of Diaphragm
27	Plunger Gage, Bottom of Ct'Bored Hole to Base of Diaphragm
28	Length of Case, Snap Gage, Go and No Go
29	Slide Gage, Large Diameter of Head
30	Eccentricity of Finished Shell Gage
31	Slide Gage, Length of Shoulder on Head, Go and No Go
32	Stand Snap Gage, Length of Head, Go and No Go
33	Stand Snap Gage, Location of Waterproof Cover Groove
34	Plunger Gage, Diameter and Depth of Countersink
35	Stand Snap Gage, Assembled Height of Tube and Diaphragm
37	Snap Gage for Depth of Washer Seat
38	Plunger Gage, Top of Socket to Top of Washer
39	Length of Outside Thread on Head
40	Depth of Diaphragm Seat, Plunger Gage
47	Snap Gage, Distance from Base to Band Groove
50	Snap Gage for Length of Center Tube
51	Ring Gage for Maximum Diameter of Center Tube
52	Ring Gage for Minimum Diameter of Center Tube
55	Snap Gage for Thickness of Diaphragm
57	Snap Gage for Radius of Diaphragm
66	Profile of Fuse End
68	Plug Thread Gage, Inside Thread of Head, Go
69	Plug Thread Gage, Inside Thread of Head, No Go
71	Ring Thread Gage, Outside Thread of Head, No Go
72	Ring Thread Gage, Outside Thread of Head, Go, Adjustable
73	Ring Thread Gage, Outside Thread of Head, No Go Adjustable
74	Plug Thread Gage, Thread in Shell Nose, No Go
75	Plug Thread Gage, Thread in Shell Nose, Go
81	Position and Profile of Band and Bevels
82	Concentricity of Assembled Tube and Diaphragm
86	Right Angle to Base Gage
88	Plug, Root Diameter of Thread in Fuse Socket
89	Profile of Finished Band
94	Snap Gage, Diameter and Depth of Washer Seat
95	Concentricity of Center Tube and Top of Shell
106	Ring Gage, Maximum Diameter of Driving Band
111	Ring Gages Diameter of Center Tube
117	Plug, Top Diameter of Head
119	Assembled Length, 75-Mm. Shrapnel
123	Gage for Checking Deflection in Diaphragm Forgings
120	Concentricity Gage for Bourrelet with Thread in Head
A	Plug, Inside Diameter of Thread in Head, Special
B	Gage for Wall Thickness, Finished Case, Special
C	Plug, Top Diameter Taper Bore Finished Case, Special
D	Gravity Plane Gage
124	Plug Gage for Concentricity of Powder Pocket and Diaphragm Seat.

the case of troops following close under a barrage fire. Shell having thin bases also increase the danger of premature explosion, owing to the very high chamber pressure used in field artillery, some types of gun being as high as 38,000 lb. per square inch. Shell having walls which are below the minimum thickness allowed are liable to upset in the gun, which always results in some damage to the gun and often destroys it.

Rotating bands which are loose, or which are too small in diameter, seriously impair the range and accuracy of the shell. This also is true of shell which are eccentric or of too small a diameter at the bourrelet. A very small variation in length or in weight will also produce a marked variation in range and accuracy.

It is also important that the physical properties of the steel shall be carefully watched, as the shell must be hard enough to fragment properly upon detonation and yet soft enough to machine, and of the proper tensile strength to resist "setback" at the time of firing from the gun.

A band which is too soft will shear in the rifling of the gun, with a consequent loss of range and accuracy.

The fuse threads must be of proper diameter and have a sufficient number of perfect threads to insure the satisfactory fitting of the fuse, otherwise a deterioration of the explosive in the shell is probable, sometimes resulting in premature explosion and sometimes in failure to explode at all.

Certain types of explosive and ordinary varnish react to form highly unstable compounds, and it is therefore essential that shell to be loaded with this type of explosive must have an interior coating free from any chemicals which would react with the explosive.

A further responsibility of the inspector is to make sure that the finished projectiles are properly protected in transit to prevent any damage to the rotating band or the fuse thread and from rust.

Among the methods of reclamation which have been used to advantage is that of plating the inside of light-weight shells with lead to bring them up to weight. About 75,000 shells were so treated.

A very important effect of this process was the great reduction in the number of light-weight shell produced. The reason for this was that previous to the use of lead plating, light-weight shell were accepted on a salvage basis. Since the introduction of lead plating, on the other hand, no such salvage acceptance is allowed, and all light-weight shell must be lead plated at the expense of the contractor. This has led to the contractors making strenuous efforts to avoid the production of light-weight shells, with the most excellent results.

[*Concluded from page 310*]

Second Lieut. John B. Pagin was formerly a mechanical engineer with the Sherman-Klove Co., Chicago, Ill.

* * *

First Lieut. H. M. Beebe was discharged after 15 months' service. In civil life he is a mechanical engineer and was employed by the Link-Belt Co., Chicago.

* * *

First Lieut. Robert G. Meyler, who has been an instructor in industrial engineering at Cornell University, has left the service. He was commissioned in June, 1917.

Maj. Charles E. Sholes, who was with the Granville Chemical Co. before entering the service, has been discharged. He was connected with the office in New York, where he lives.

* * *

First Lieut. I. W. Pettengill of Haverhill, Mass., was discharged after 16 months' service. He is a mechanical engineer, and was employed by the Wagner Electric Co., St. Louis, Mo.

* * *

Capt. Henry A. Brown of Kenmore, N. Y., was released on Jan. 31. He had been in the service over 20 months, and left the Brown & Sharpe Manufacturing Co., of Providence, R. I., to enter.

* * *

First Lieut. Xanthers R. Smith of Jenkintown, Penn., has been discharged after 15 months' service. He is a mechanical engineer and was employed previously by the Atlantic Refining Company.

* * *

First Lieut. Gerald H. Deacon of Germantown, Penn., has left the service. Before receiving his commission in January, 1918, he was with the Robert Gair Co., Brooklyn, N. Y. manufacturer of paper containers.

General Jamieson Renews Consulting Practice

Brig.-Gen. Charles C. Jamieson, who was discharged from the service at his own request on Jan. 3, 1919, has renewed his connections with George W. Goethals & Co., Inc., 40 Wall St., New York, as vice president and partner. General Jamieson graduated from the Military Academy in 1892 and retired as a major in 1910. He then spent five and a half years in the manufacture of agricultural implements and harvesting machinery, three of which were with the Walter A. Wood Mowing and Reaping Machine Co., and two and a half as manager of factories for Deere & Co. He resigned from Deere & Co. in 1916, opened offices as consulting engineer in New York, and organized the firm of George W. Goethals & Co., which is engaged in consulting and organization work in connection with industrials.

Lieut.-Col. William H. Eaton Resumes Civilian Activities

Lieut.-Col. William H. Eaton has resumed his position as treasurer and general manager of the Eaton, Crane & Pike Co., Pittsfield, Mass. Colonel Eaton was commissioned a captain on Aug. 1, 1917, and became assistant to Brig.-Gen. (then Colonel) C. B. Wheeler, Chief of the Supply Division, Ordnance Department. When General Wheeler was promoted to be Acting Chief of Ordnance Colonel Eaton was his assistant until General Wheeler was appointed Chief Ordnance Officer of the American Expeditionary Forces, at which time Colonel Eaton sailed for France to continue in the capacity of assistant to General Wheeler. Colonel Eaton, who is a graduate of the Peekskill Military Academy, became secretary of the Eaton, Crane & Pike Co. in 1907 and treasurer and manager in 1912. He is president of the Union Coöperative Bank of Pittsfield, director of the Pittsfield National Bank and trustee of Trinity College of Hartford.

Attention!!

If you believe in industrial education—

If you believe in giving American boys a chance--

If you believe in training mechanics who think about their work in addition to merely doing it—

If you believe in developing to the utmost America's resources and increasing to the utmost America's wealth—

If you believe in these things, sit down this minute and write your Congressmen and Senators to get back of the movement to let the American people make use of the tools they have bought and paid for.

Mention Representative C. P. Caldwell's bill, H. R. 15625, introduced February 4, 1919.

65th Congress
3d Session

H. R. 15625

In the House of Representatives, February 4, 1919.

Mr. CALDWELL introduced the following bill, which was referred to the Committee on Military Affairs and ordered to be printed:

A BILL

To provide further educational facilities by requiring the War Department to loan certain machine tools not in use for Government purposes to trade and technical schools and universities, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War shall lend to trade and technical schools and universities and other recognized educational institutions which in the discretion of the Secretary of War should have such equipment the machine tools suitable for their use which are owned by the United States of America, which are under the control of the War Department, and which are not being used for Government purposes: *Provided, however,* That each institution so equipped shall be responsible to the United States of America, under regulations to be prescribed by the Secretary of War, for the proper care and safe return of such equipment when demanded, ordinary wear and tear excepted.

EDITORIALS

Re-education of Returned Soldiers

SOME of the agencies which are engaged in the re-education of returned soldiers are attacking the problem in a somewhat different manner than has been understood in some quarters. Instead of trying to find means whereby appliances can be made to enable a machinist to return to his trade considerable success is being attained by finding the man's capability and inclination along allied lines or even in distinctly different lines of work. In the case of a man who has lost a hand or an arm, for example, the attempt is made to find some occupation which he can follow with the use of one hand instead of fixing him up with appliances to return him to his old trade.

While it is not of course possible to do this in all cases, and while all crippled men are not capable of other vocations, the idea of reëducation is being extended so as to cover new education along different lines. If, for example, the man has been an expert machinist, thoroughly understanding the operations of the various machines in the shop, he may be trained to read blueprints and to become a planner of work for others, thus utilizing his shop experience and at the same time enabling him to make himself more useful than before without the aid of mechanical appliances.

When additional education will fit a man for a better job, and the man has the capacity for this education, it is certainly much better to reward his sacrifice by promotions of this kind than to send him back into the shop under a handicap, which is not only physical but, what is equally undesirable, also a constant source of mental depression.

Profiting by Our Mistakes

WE LEARN by doing, and in doing we make many mistakes. But we do not learn unless we acknowledge that we have made mistakes and try to correct them or prevent their recurrence. The best teachers do not gloss over the mistakes of their pupils. They point out the errors so that they and others may not make the same mistakes again.

We made many mistakes in our war preparation and activities, as was to be expected. But in too many cases we are trying to deceive ourselves into believing that everything went just as it should when we knew that this was not the case. We are losing a great opportunity of profiting by our mistakes by attempting to hide them under camouflage of various kinds.

There are good and sufficient reasons for failure in many cases, and nothing is to be gained by indiscriminate censure of individuals. The greatest reason for failure can probably be found in the selection of men unfitted for their particular job and in the handicapping of good men by impractical conditions. But we shall lose all opportunity for profiting by our mistakes if we continue the application of whitewash instead of looking the facts squarely in the face and endeavoring to profit by them. And unless we do this we are liable to make the same mistakes again.

It is quite natural that the individuals involved should seek to shield themselves and to try and gather what glory they may. But the individual must give way to the best interests of the nation. His reputation must stand or fall on accomplishment or failure.

It is said that to err is human and to forgive divine. But while we may be ready to forgive the errors made we can hardly be expected to forgive deliberate misrepresentation, copious applications of whitewash and claims to inventions and improvements which clearly belong to someone else. Before we forgive the prodigal and take him back into the family he must acknowledge the error of his ways and not pose as either a hero or a martyr.

Rewarding Fair Treatment

THE time is coming when we shall have practical demonstrations as to how long we remember the kind of treatment we received during the stress of the past four years; to show perhaps whether it pays to take advantage of every opportunity or to play fair in all things.

The machine-tool builder of this country showed with few exceptions a desire to handle matters fairly and to give considerate treatment to all. The prices of machine tools advanced less than many other metal products, and no increase has taken place since June, 1917.

There has been, however, a difference in the treatment accorded customers, as was to be expected. Traits of individual character will show themselves under stress or when opportunity offers. The time is now coming when those who were well treated can show their appreciation, and those who were gouged and taken advantage of can also show that they do not forget unfair treatment and will take their trade where they were well cared for.

While the majority of machine-tool builders were reasonable in their price advances there were a few cases where an urgent demand for a machine was very apt to boost the price; where an inferior machine could be obtained more readily, but at a higher price, than the best. On the other hand there are a few cases where builders of machines of the highest grade advanced prices barely enough to cover the increases in materials and labor and refused to accept any bonus for early deliveries.

Unless men of this kind are rewarded by continued orders from those they served so well there is little incentive in playing the game squarely. Is it not the duty of every buyer to take an inventory of his treatment during the past few years and to reward those who have treated him with fairness and consideration? This will give a direct incentive in addition to the self-satisfaction of having done the fair thing.

The "Coverage" of the Compensation Acts—II

By CHESLA C. SHERLOCK

The first of the series on "The Coverage of the Compensation Acts" appearing in this paper defined the status of employers. This, the second contribution, establishes who are employees and when they are entitled to compensation, with an incursion into the question of dependents and when they come under the protection of the compensation laws.

UNDER the early compensation laws there was a great deal of uncertainty as to the intent and purpose of this legislation, and men who had been schooled in the theories of the common law could not catch the spirit of the newer protective acts. Consequently we find that while the courts have been concerned with the question of who are employers under the compensation laws there has been probably more litigation over determining who are employees.

In considering who are employees it will be necessary to enlarge the word to include all persons who are entitled to compensation, and we will consider not only their rights, but also the question of dependency and the rights of dependents to compensation. To ascertain the status of employees and stop there is plainly leaving only half said in determining the "coverage" of the acts.

Most of the acts attempt to define the term employee just as they attempt to define the term employer, and the same objections to accepting the statutory definition of employees apply with equal force as they did in the case of defining employers. In fact, the courts have taken more liberties with the legislative definition of employees than of employers.

When an Employee May Recover Damages

Once an employer has become bound by the terms of the compensation acts there are two vital considerations that determine the right of a workman to recover compensation, namely, Was he an employee? and Did his injury arise by accident out of and in the course of his employment?

These tests apply to all of the acts, which agree that no person is entitled to compensation unless he or she was an employee; and no employee is entitled to compensation unless the injury was received by accident arising out of and in the course of the employment.

If a workman walks into an establishment and goes to work he is not an employee because there is no contractual relation between employer and employee. The word employee carries with it an implication of continuity of service. It does not signify merely temporary or transitory employment. It means regular, steady, continuous service. Casual employees are not employees within the technical meaning of the acts. The acts specifically exclude them, for industry should not be charged with losses where the workman is a "floater," a "drifter," or mere casual worker.

Workmen who stand in the position of independent contractors are not employees within the meaning of the acts and are not entitled to compensation. Let me illustrate. A man operating a shop had a number of trees on his premises which interfered with the light on cloudy days. He called one of his employees, who was about to take a vacation, and asked him if he would like to spend his vacation cutting down the trees. The workman consented, the agreement being that the workman would receive $40 and the wood the trees yielded. He was to use any method he might choose and the employer was concerned in the work in no way. This man was an independent contractor, and when he was injured by a falling limb he was not entitled to compensation. If the employer had called him in and told him to cut down the trees in a certain manner and had paid him his regular wages he would still not be entitled to compensation in some states because the work he was doing was casual and not in the employer's usual line of business.

In the technical sense employees are deemed to be workmen following a certain employment continuously and at a regular wage. The mere fact that the employment recurs with more or less frequency is not sufficient. A physician is not an employee, nor are professional nurses, pastors or public lecturers.

Clerks Not Always Employees

Not every person employed in an industrial establishment would be regarded as an employee even though his employment was regular and for hire. Clerks, stenographers, assistants, executives and the like are not employees within the meaning of the compensation acts. There are instances when clerks may be entitled to compensation, but this depends on the character of the work done and not upon the title. If a clerk is subjected to all of the hazards of the business he will be entitled to compensation in most of the states, although he is called a clerk, and clerks are expressly excluded from participation in the benefits of the acts.

It has been said that the test to apply in such cases is to determine whether a man earns his daily bread with his hands or by his intellect. There can be no doubt but that those who labor with their minds are not employees within the sense of the compensation acts, but even this test is manifestly unfair.

A lawyer, doctor, lecturer, engineer, executive or any other person depending for his income on the fruits of intellectual labor is not an employee in the sense of the compensation acts, but he may become an employee under certain conditions as in a case that involved a school-teacher. It was urged that no compensation could be paid because teachers depend for their income upon intellectual labor, but it was shown that this teacher performed her service in a country school where she was not only teacher but janitor as well. She was injured while building a fire in the schoolhouse before school commenced, and she received compensation.

The decisions of today tend to follow this broader rule. Clerks who are required to do things that subject them to hazards not ordinarily incurred by clerks who merely keep books or get out reports are entitled to compensation.

Industrial workers are commonly employed on some sort of a commission basis, either sharing in the profits or being paid a bonus. But since independent contractors are excluded from the operation of the act when they are themselves injured it naturally follows that the courts would be called upon to determine whether a workman employed on a commission or a bonus basis was an employee.

While a person is not ordinarily deemed an independent contractor unless he works for a lump sum the courts quite universally hold that the mere fact that a workman is employed on a commission basis will not take him out of the operation of the compensation acts. The test to apply in such cases is as to the control of the employer over the method of work, his right to discharge or to put the employee on other work or anything that tends to establish a relationship of employment rather than of independent employment.

Compensation for Officer of Corporation

Simply because an employee is an officer in the corporation employing him will not deprive him of compensation in case of injury, but in this connection some wages are necessary in the character of employee. A bank director in Connecticut was held not to be entitled to compensation as an employee of the bank when had he been the director of a tool-manufacturing establishment and also a machinist in its employ he would be entitled to compensation if injured in the latter employment.

Certain individuals who have no legal standing, such as convicts or others who are not paid for the work they do, cannot enjoy the status of employees under the compensation acts.

In New York the statute defines an employee as "a person who is engaged in a hazardous employment in the service of an employer, carrying on or conducting the same upon the premises or at the plant, or in the course of the employment away from the plant of his employer." It will be observed that this definition limits recovery in New York to persons engaged in "hazardous employment." A list has since been compiled by the legislature setting out the employments deemed hazardous.

In Iowa an employee is defined as "one who works under a contract of service, express or implied, or apprenticeship for another," but the definition states that clerks subjected to the hazards of the business shall be entitled to compensation, so it might be inferred from that expression.

The act is limited to employees in "hazardous occupations" in Alaska, Arizona, Illinois, Kansas, Louisiana, Maryland, Montana, New Hampshire, New Mexico, New York, Oklahoma, Oregon, Washington and Wyoming.

Every state having compensation legislation, either expressly or by implication, exempts farm labor and domestic servants from the benefits of the system.

The recommendation of the American Association of Labor Legislation as to what employees should receive compensation is as follows: "It is believed that sufficient progress has now been made in public education on the problem and in the development of efficient and economical machinery for insuring the employer against his compensation liability to justify the inclusion in the system of all employments. The only exception which should be made is of casual employees in the service of employers who have only such employees and who therefore cannot fairly be required to carry compensation insurance policies. Such policies, on payment of a small additional premium, are now drawn so as to embrace casual as well as regular employees. No serious burden is therefore entailed on employers, even of domestic servants, in making them liable to pay compensation to casual employees."

It is interesting to note that Alaska, Kansas, Louisiana, Nevada, New York, Oklahoma and the new federal act have followed the recommendation of the association and have allowed casual employees to participate in the benefits of the compensation system.

We have found that an employee is one engaged in the service of an employer, which service is continuous, regular and for hire. The elements are: (1) A contract of service, either express or implied, oral or written, wherein the employee enters into the service of the employer. There must be a contract of hiring, for the compensation acts are by implication of law written into every contract of service where such acts are in force. (2) The employees excluded are farm laborers, domestic servants, clerks, casual employees (in some states they are compensated), independent contractors and the officers of a corporation or the representatives of the employer.

The Status of Dependents

There is a great deal of misunderstanding in some quarters regarding the term dependents and just what it covers. It should not be thought that it is interchangeable with the terms heir or beneficiary. A dependent may be an heir and a beneficiary, but a mere heir or beneficiary could not obtain compensation as a dependent under the compensation acts.

The acts seek to define who are dependents, just as they define employers and employees, but there are many cases where further light is needed to determine the matter justly. In defining the word liberally a dependent is any person who is actually dependent upon the earning capacity of the workman for support. It may even include those who are not his blood relatives.

It is not sufficient to determine whether the so-called dependent was capable of supporting himself or herself. All the courts want to know is, was this person actually dependent upon the injured or deceased workman for support, and did such workman actually support the person. If so, he or she is entitled to compensation. Many of the acts provide that a wife is not deemed a dependent unless she is living with her husband at the time of the injury, the intention of the legislature being to deprive wives who had separated from their husbands from obtaining compensation, but so far as aliens were concerned the courts have held that for the purpose of the acts a wife was living with her husband when he contributed money toward her support even though thousands of miles might separate them.

The question of what to do with nonresident alien dependents is a matter which is only now coming to our attention. From the first most of the states have provided compensation for them, some, however, decreasing the amount they might recover.

There is no doubt but that we have been liberal with our liberty and the advantages of citizenship in the past. We have allowed aliens who were undesirable to come to this country, and our industries have given them employment. When a situation of great menace to our commonwealth arose many of these aliens did not hesitate to burn down factories, blow up shops and munition plants, wreck bridges and otherwise destroy our industrial effectiveness. Most of these aliens came to this country for no purpose other than to make money. A majority of them left their dependents in other countries, intending to return as soon as they had accumulated money enough to elevate them in the eyes of their countrymen, and many did not even sympathize with our form of government or our ideals.

Yet the police power of the state is used and probably will continue to be used to compel American employers to divide their property with nonresident alien dependents, people who have never been to this country and who have contributed nothing to our society or to our ideals. But American employers do not take kindly to it and perhaps the solution of the matter lies in refusing employment to those who have not taken out their first citizenship papers or who have not brought their families to this country.

This evil was most apparent when we declared war on the imperial German government, after which the commissions were bombarded with claims from dependents residing in the countries of the Central Powers.

There are several kinds of dependency as defined under the acts. Persons may be either totally dependent or partly so. When totally dependent they are entitled to the full benefit of the compensation act, but when partly dependent, the employer is liable only for his share, as determined by the statute, of the loss which they have suffered by reason of the withdrawal of the contribution ordinarily made by the deceased workman.

Persons such as husband or wife, parent or child, are presumed to be totally dependent, and the question of actual dependency cannot be raised by the employer.

No hard and fast rule can be formed as to what constitutes dependency. Ordinarily it means the condition arising where one looks to another for support, for the necessaries of life, or for the wherewithal to maintain himself in the same station of life maintained by the deceased workman. No employer can be compelled to pay compensation to maintain a dependent in any other station of life than that in which the deceased maintained such dependent, but where total dependency is presumed by law this may in fact occur.

Two tests that any employer can use to satisfy himself if there is dependency or ground for the claim are: (1) There must be actual dependency in fact as well as in appearance or claim; unless it is presumed the mere fact that one might ordinarily be deemed a dependent is not sufficient evidence of it. (2) There must have been actual contributions made by the injured workman to the person claiming dependency and such contributions would have been of an amount which can be ascertained or established and must have occurred with reasonable frequency.

The mere casual sending of money to one is not evidence of dependency, but might properly be more of an evidence of the liberality of the injured workman.

The Annual Meeting of the Society of Automotive Engineers

This year's annual S. A. E. meeting, as usual, was held in New York in conjunction with the Automobile Show and there was presented a three-day program of professional and social sessions at which there was a good attendance. The social features included two luncheons, a ladies' night at the Astor and a victory dinner, followed by a roof-garden whirl to wind up the proceedings.

The business meeting on Wednesday morning disposed of the various reports, after which came the reading of professional papers on "Tanks," by Lieut.-Col. Alden; "Principles of the Wheeled Farm Tractor," by E. R. Hewitt; "Automotive Applications of Marine Engines in the War," by G. F. Crouch, and "Automotive Ordnance Apparatus," by Lieut.-Col. Wall.

The afternoon session began with a "Symposium on the Probable Effect of Aeronautic Experience on Automobile Practice" by three of the leading authorities on these subjects, Henry H. Crane, Howard Marmon and O. E. Hunt. This was followed by papers on "High-Speed, High-Efficiency Engines," by D. McCall White, and "The Story of the United States Standard Truck," by J. G. Utz.

On Thursday morning the fuel session occupied the center of the stage with papers on the fuel problem by experts from the U. S. Geological Survey, the Bureau of Mines, the Bureau of Standards and the Bureau of Oil Conservation. The general trend of these papers pointed to the improvement of engines rather than to the increase of production of gasoline or better refining methods as the solution of the problem. The suggestion was made that engines be divided into two classes, one to embrace truck and tractor motors which could be built to burn a low-grade fuel because of their practically constant speed and the needlessness of flexibility and accelerative ability, and the other to consist of the passenger-car and airplane engines in which flexibility, acceleration and light weight demand a better quality of gasoline.

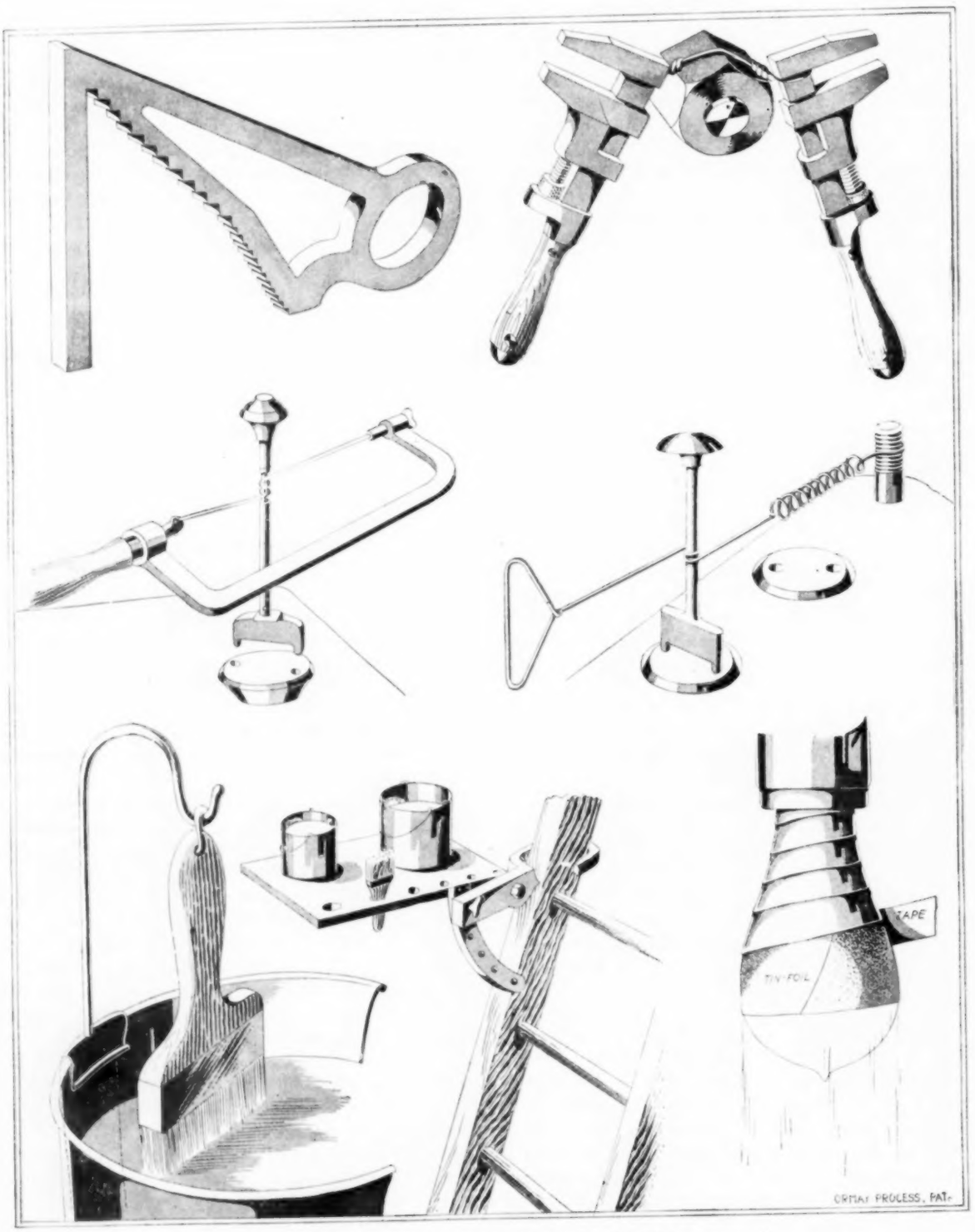
The Aeronautic Session on Thursday afternoon brought out an attendance which attested to the widespread interest in this field. Papers by Alexander Klemin and J. G. Vincent recounted the experiences of the Army with the problems of airplane and engine design and testing. The Navy's point of view on the aspects of the situation was explained in papers by Commanders Coburn, Richardson and Towers.

A paper on "Making the Airplane a Utility," by Grover C. Loening, emphasized the need of extreme speed in commercial airplanes to enable them to compete with express trains and to reduce the danger incident to the long distances between the existing landing fields. Attention was called to some of the disadvantages of the modern airplane; the uncomfortable muffling up of the occupants, the unpleasant factors of noise, oil and smoke from the exhaust and the drain of nervous energy incident to long trips. Much of this could be obviated by proper protection of the fuselage of the machine.

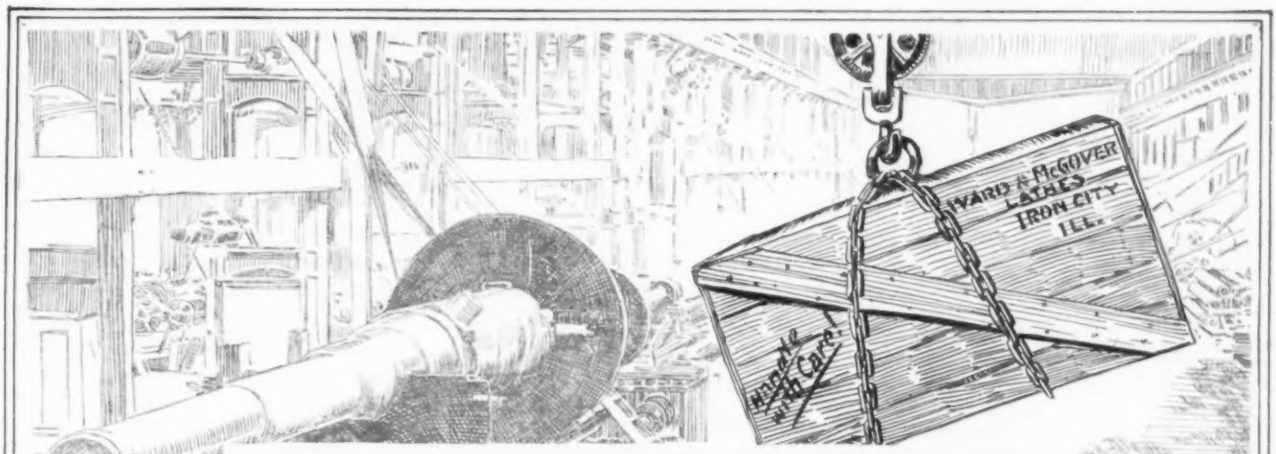
The meeting closed with a paper on "Forest Products for Aircraft Use," by Clyde H. Teesdale of the Forest Products Laboratory.

FOR SMALL SHOPS *and* ALL SHOPS

By J. A. Lucas



TIME-SAVING AND EFFICIENCY DEVICES

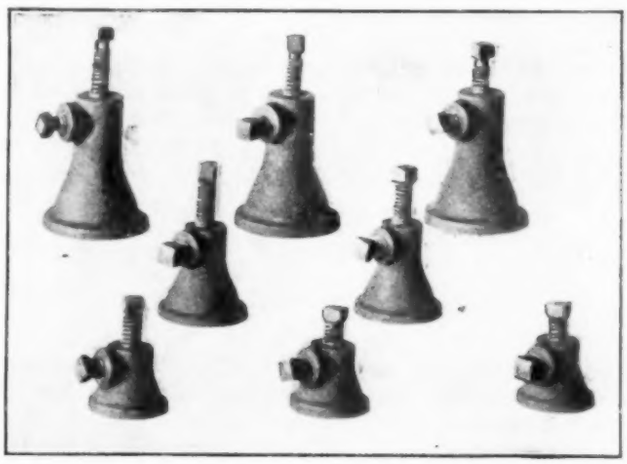


SHOP EQUIPMENT NEWS

Edited by
Stanley M. Banfield

Kent Planing-Machine Jacks

The Kent Machine Co., Kent, Ohio, is now marketing a line of planing-machine jacks as here shown. These jacks are made in three sizes, covering a range of from 2 to 6 in. The bases of the jacks are made of cast iron, the adjustment being secured by means of a screw placed in the top of the casting. This is prevented from turning while in use by means of a setscrew at the

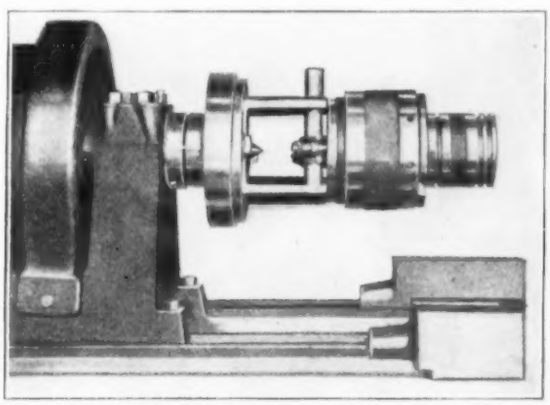


KENT PLANING-MACHINE JACKS

side bearing on a brass plug, which in turn bears on the raising screw and prevents mutilation of the thread. The screws for all sizes for both adjustment and for clamping have the same sized head, thereby entailing the use of but one wrench.

Hartog Piston Chuck

The piston chuck shown in the illustration has recently been placed on the market by the S. D. Hartog Manufacturing Co., St. Louis, Mo., and is intended for the use of garages, service stations or other places where it is desired to re-turn the piston-ring grooves in automobile or gas-engine pistons. A particularly desirable feature of this chuck is that the pistons may be re-turned without the necessity of removing the connecting-rod. It is also claimed that the method of holding the piston avoids the liability of cracking it, as is often done when it is held in chuck jaws. The



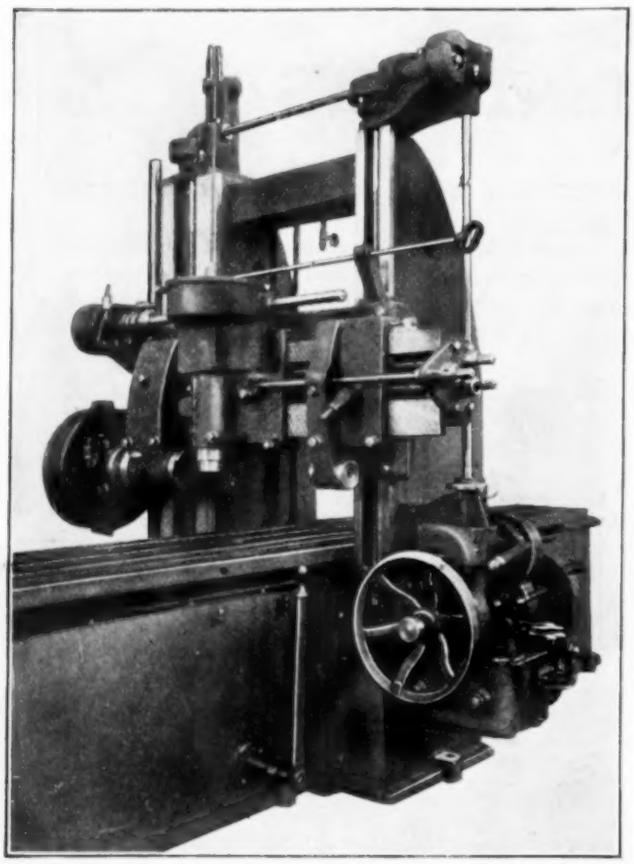
HARTOG PISTON CHUCK

chuck is clamped to a faceplate, after which the piston is put in place and a pin is put through the sides of the chuck and through the crankpin bearing of the rod. An outer sleeve on the chuck body is then screwed forward, carrying the faceplate up against the base of the piston, and thus holding it securely in place. The sleeve is knurled and also provided with holes so that a spanner wrench or pin can be used.

Newton Heavy-Duty Horizontal Keyseat Milling Machine

The heavy-duty horizontal keyseat milling machine shown in the illustration has just been placed on the market by the Newton Machine Tool Works, Inc., 23d and Vine Sts., Philadelphia, Penn. It is stated that the machine is very flexible in control and that it is particularly desirable for long shafts because the table is supported its full length and does not overhang. The base and table can be made to mill any desired length. Another advantage of this type of machine is that a

cutter can be mounted on the horizontal spindle to allow milling keyseats in shafts in multiple. The machine can be equipped with centers with quartering devices for accurately milling on the quarter the keyseats of locomotive axles, and when these special quartering fixtures are used the keyseats in both ends may be finished with the original setting if this is desired. The vertical spindle is used to end keyseats when necessary, such as those in eccentric strap bearings. The vertical spindle saddle is mounted on the flat cross-rail and has a hand cross-adjustment employing a rack-and-pinion mechanism. The independent hand vertical adjustment of the vertical spindle sleeve is controlled by a worm and



NEWTON HEAVY-DUTY HORIZONTAL KEYSEAT MILLING MACHINE

Diameter of horizontal spindle in bearing, 4½ in.; diameter of horizontal spindle through driving gear, 4 in.; side adjustment of horizontal spindle by hand, 4 in.; distance from center of horizontal spindle to under side of cross-rail, 2¼ in.; maximum cutter swing on horizontal spindle, where vertical spindle saddle does not interfere, 10 in.; maximum cutter swing under vertical spindle saddle, 6 in.; width of work table over working surface, 20 in.; length of table to mill, 10 ft.; width between uprights, 26 in.; maximum height from center of horizontal spindle to top of work table, 33 in.; maximum height from end of vertical spindle to top of work table, 35 in.; diameter of vertical spindle, 2 in.; independent hand vertical elevation of vertical spindle sleeve, 6 in.; vertical spindle adjustable to maximum height of 2 in. above the center of the horizontal spindle; weight complete, 22,000 pounds.

wormwheel connected to the spindle rack pinion, the control being actuated by a spline shaft carried to the right-hand end of the cross-rail. The horizontal spindle head is also adjustable by hand across the rail by a screw controlled from the right-hand side of the cross-rail. Nine changes of gear feeds are provided for the table from a box in which are mounted adjustable sleeves giving the changes without the removal of gears. The table is also equipped with reversing fast power traverse. The cross-rail is counterweighted and is equipped with both hand adjustment and reversing vertical fast power traverse. A micrometer adjustment is provided on the shaft transmitting motion for the vertical adjustment of the cross-rail for adjusting the cutter on the horizontal spindle to the depth that is required.

This horizontal spindle is driven by a bronze wormwheel and a hardened-steel worm which is fitted with roller thrust bearings. The vertical spindle is driven by a wormwheel and spiral gear of bronze; both of these drives are incased to permit of continuous lubrication. The horizontal spindle is fitted with a Morse taper, a holder, a face keyway, and through retaining bolt, the vertical spindle being equipped in the same manner. The outer support on the cross-rail is adjusted by means of a rack-and-pinion mechanism, the elevating screws having top and bottom bearings to insure their operation in tension. The work table has three finished T-slots, drilled stop-pin holes, and is surrounded by a pan for draining off the lubricant to a tank in the base. The drive to the table is through a spiral pinion and angular rack. Practically all bearings are bushed, all gears in the driving train are steel or bronze, and those in the feed train except the large spur gear are also of steel or bronze. A feature of the machine is that all the controls are brought together convenient for the operator. The vertical lever at the center engages the primary clutch which controls all movements in the direction of rotation for the movement. The upper horizontal lever at the right engages the clutch controlling the power vertical movement of the cross-rail. The lower horizontal lever at the right controls the clutch for engaging the table feed and fast power traverse. Two latch levers at the right control the feed-gear combination. The handwheel controls two hand adjustments, namely, that of the table and the vertical adjustment of the cross-rail.

Products That Sweden Needs From the United States

The following products are among those which Sweden particularly needs from the United States: Food of all kinds; machines and machine tools; lubricants; lubricating oils; copper; nickel, tin and like metals; sulphur; harvesting machinery; cotton; wool; leather; rubber; coal; copper wire. Sweden would buy toys; cotton, wool and silk cloths; cotton, wool and silk underwear; cotton, wool and silk stockings; shoes; all kinds of clothing for men, women and children; motor cars; thread; typewriters and adding machines, and so forth.

Sweden does not need wood and wood pulp; iron and steel, except cheap foundry iron, which the high price of coal makes exceedingly costly to manufacture; turbines; oil engines; electrical machinery.

It is realized that raw material will be rationed, and that orders for many other things cannot be completely filled, but it seems as if the present possibilities could advantageously be made known to interested manufacturers and exporters of the United States.—*Commerce Reports.*

LATEST DEVELOPMENTS IN THE AUTOMOTIVE INDUSTRIES

Aircraft · Motor Trucks · Tractors

The Miller Rubber Co., Akron, Ohio, manufacturer of Miller Geared-to-the-Road tires, has begun the manufacture of heavy-duty pneumatic tires for trucks.

To manufacture its standard air-brake equipment for motor trucks and trailers the Parker Appliance Co., Cleveland, Ohio, is planning new quarters with 20,000 sq.ft. of floor space in Cleveland.

The sale of the 60,000 shares of the American Bosch Magneto Corporation, which was taken over by the Alien Property Custodian, has been completed. The entire amount of stock was sold at $65 a share.

The War Department has appointed a special official for disposing of the big quantities of surplus motor trucks and equipment and for selling the 50,000 American motor trucks to the French and Belgian governments.

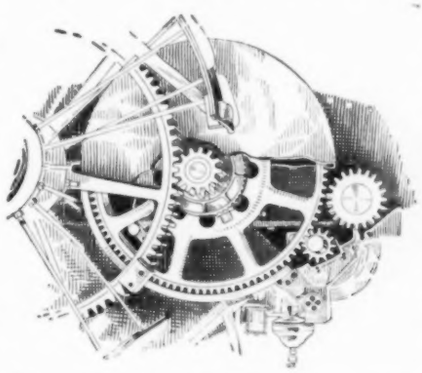
On returning to a peace-time basis the General Motors Truck Co. announced its intention of price reduction for every G. M. C. truck model. The many G. M. C. trucks used in the war won a record for excellent abilities.

The 1919 production schedule of the Fordson tractors manufactured by the Henry Ford & Son Co. calls for 100,000 tractors. This means a daily production of about 325 tractors instead of 225 as at present. In 1918 the company turned out and sold 30,000 tractors.

The Knox Motors Association of Springfield, Mass., manufacturing the Knox tractor, has fixed the price of the model 35 tractor at $5500 f.o.b. factory and that of the model 36 tractor at $6000 f.o.b. factory, with an additional charge of $100 for cleated steel driving wheels.

During the Packard war-product exhibit at Detroit a demonstration was given to show the tremendous power of the Liberty motor. This famous aviation engine was mounted on a Packard 3-ton truck weighing 7000 lb., from which the motor, radiator, hood and transmission had been removed. The air propeller drove the truck not only at the speed of a swift passenger car, but also slowly and smoothly in abrupt turns, figure eights and serpentine curves.

The illustration shows an interesting tractor transmission design manufactured by the Minneapolis Steel and Machinery Co. A single-spur pinion on the crankshaft engages the differential and at each end of the differential shaft are the bull pinions which drive the bull gear. This design does away with



the commonly used intermediate gear, which is a well-known source of tractor transmission troubles. The transmissions using an intermediate gear must have two gears running on it, and consequently they get twice as much wear as any other gear, because the teeth of this gear cannot be made any stronger since they must correspond with those in the main pinion and differential.

There are 6,361,502 farms varying in size from less than 20 acres to more than 1000 acres in the United States. During 1916, 1917 and the first part of 1918 150,955 tractors were manufactured in the United States. A comparison of the number of farms with the number of tractors manufactured up to June 30, 1918, shows that a tractor was manufactured for only one farm in 42.

Piston clearance in kerosene engines is larger than in the gasoline motors because the kerosene-engine piston is subjected to higher and more sustained temperature than that of the gasoline motor. Experiments with various types and sizes of kerosene-engine pistons show that the body clearance should range from one to one-half thousandths per inch of diameter, and the rest of the piston should be tapered toward the head with a clearance of four to five thousandths per inch of diameter at the extreme top in order to take care of the additional expansion and avoid the piston seizing and scoring the cylinders or at least a heavy preignition.

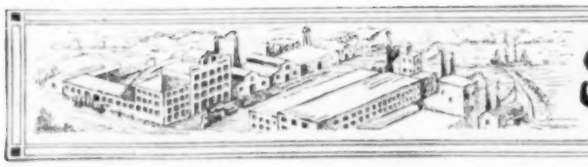
The newly incorporated United Aircraft Engineering Corporation, New York, has increased its capital from $200,000 to $500,000. The company was organized by E. G. Diffin, Roy U. Conger and M. B. Stout and has offices at 52 Vanderbilt Ave., New York.

That the rural motor express is a healthy business possibility is shown by a Canadian company which has been capitalized at $300,000. The company is operating a line out of Toronto to London westward and to Hamilton and Buffalo southward, taking in all the way stations. The length of the route is approximately 200 miles.

The new Metz passenger car will be a six-cylinder, 45-hp. model with 117 in. wheelbase and 32 x 4-in. tires. A feature of this new model is the replacing of the Metz friction drive with a three-speed selective-gear transmission. The car will be equipped with an electric starting and lighting system and will sell for $1495.

An allied aviation conference of representatives from France, Great Britain, Italy, Belgium and the United States will be held in Paris to incorporate an aeronautical clause in the peace settlement. One of the questions to be settled by the conference will be that of adopting regulations to prevent airplanes engaged in international mercantile traffic from flying over frontiers and delivering their cargoes withot stopping at the custom house to pay duty.

Notes on Airships for Commercial Purposes," a report issued by the British Air Ministry, contains interesting suggestions for the future of aerial transportation. To eliminate the commercial competition between the two types of aircraft, the use of airplanes is suggested for distances under 1000 miles, leaving nonstop flights of more than 1000 miles to dirigibles. Large airship stations 2000 to 3000 miles apart should be established mainly for transoceanic traffic and airplanes used to bring merchandise and passengers to this airship center from neighboring countries. By operating aircraft in this way airplanes would compete with railroads, and airships with ocean steamers, the advantage over the present transportation system being in the saving of at least 50 per cent. of the average time of transit.



Sparks from the

National Merchant Marine Association

Created for the Purpose of Carrying On Propaganda Advocating a Large American Merchant Marine

As a result of the American Merchant Marine conference held at the Smithsonian Institution, Washington, Jan. 22 and 23, Senator Joseph E. Ransdell of Louisiana, presiding, and to which invitations were extended to all industrial elements of the country, a new organization was created to be known as the National Merchant Marine Association, the purpose of which will be to carry on a nation-wide propaganda in advocacy of a large American merchant marine. R. Goodwyn Rhett, former president of the Chamber of Commerce of the United States, was elected chairman and Winthrop L. Marvin of Boston secretary.

The governing body of the organization will consist of the officers and a council of not less than 30 members, the nucleus of which will be members of the resolutions committee which recommended the creation of the new organization.

Strong opposition was made to the report of the resolutions committee by Rear Admiral Francis Bowles, in charge of the Emergency Fleet Corporation at Hog Island, who contended that the interests of the various parties engaged in shipping were in the United States well represented by the American Steamship Association. He said that he was of the opinion that it was inappropriate to attempt the organization of any body representing private interests when the nation's interests were at stake.

Assurance that the United States Navy would lend every aid to the new organization was made by Commander Charles Belknap, U.S.N., who stated that the Navy should train the men and officers of the merchant marine and that they should then be made members of the Naval Reserve. "The Navy will back any legislation which promises to promote the interests of the merchant marine," he said.

J. J. Powell, vice-president of the Bethlehem Shipbuilding Corporation; Homer L. Ferguson, president of the Newport News Shipbuilding and Dry Dock Co., and Holden A. Evans, president of the Baltimore Dry Dock and Shipbuilding Co., spoke for the builders and were united in their opinion that the cost of building American ships was a barrier against any attempt to establish a merchant marine unless the nation assumed the undertaking.

Mr. Powell stated that the difference between the cost of a ship in Great Britain and one in this country was approximately an increase from about $25 or $35 a ton before the war to $100 today. A great part of this cost, he said, was due to the increase of the cost of labor.

Mr. Ferguson said that he favored laws and treaties being made which would confine trade between the United States and other countries to ships of either those countries or the United States. This, he said, would assure each country having a merchant marine commensurate with its commerce.

Mr. Evans indorsed the presentation of Mr. Ferguson and declared that he favored the immediate leasing of Government ships to private operating companies, which should be given options of five years in which to purchase them, giving $75 a ton as a value on which leases should be fixed.

Matthew Woll, representing Samuel Gompers, president of the American Federation of Labor, said that the federation would join the organization if it could be assured that seamen were not to be reduced to serfdom.

Efforts will be made, it was stated, to have legislation enacted under which the American merchant marine may develop favorably.

Among members of the resolutions committee named by Chairman Ransdell were H. A. Wheeler, president of the United States Chamber of Commerce; P. A. S. Franklin, president of the International Mercantile Marine; J. H. Pruitt, president of the Masters, Mates and Pilots' Association; F. L. Sanford of the Southern Pine Association, and C. E. Gunsky of San Francisco.

J. Parker Kirlin of New York headed the committee on organization.

* * *

Bureau for Engineers

The Cornell Society of Civil Engineers has established a Registration Bureau for Engineers at 30 East 42d St. Approximately 1000 Cornell engineers who have been in the military or naval service have been registered. The bureau supplies trained men without charge to employers. Alumni of the Cornell engineering colleges and employers are invited to make use of the service.

* * *

Iron That Can Be Whittled

It is well known that rapid cooling of hot metals hardens them. That the opposite is true has recently been demonstrated in striking fashion by the General Electric Co. One of its scientists annealed American ingot iron surrounded by hydrogen gas for three hours at a temperature above 1600 deg. F. The product was very little harder than the softest copper and can be whittled with a knife.—*Brass World.*

Monoplane Ascends 19,500 Ft. Carrying Three Passengers

A new record for monoplane altitude was made by Maj. R. W. Schroeder, Air Service (Aeronautics), the holder of the American altitude record, on Jan. 18 at Dayton, Ohio.

According to reports received from the chief of the Technical Section, Division of Military Aeronautics, McCook Feld, Dayton, Ohio, the Loening monoplane climbed to a height of 19,500 ft., carrying three passengers weighing 470 lb. The pilot was Maj. R. W. Schroeder, the observer Lieut. George V. Elsy, and the mechanician K. A. Craig. The previous altitude record for a monoplane with three passengers is understood to be about 16,000 ft. A report from Mr. Loening gives the time of climb as 31 min., which will average 500 ft. per minute.

The plane piloted by Major Schroeder was the two-seated Loening monoplane built by Grover C. Loening of Long Island, N. Y. The power plant is an eight-cylinder Hispano-Suiza engine, which has driven the monoplane as fast as 145 miles per hour.

* * *

Tractor Schools

Schools for teaching the operation and mechanism of farm tractors are being held in different parts of Iowa this winter. The duration of the tuition varies from two to several days, and is free to anyone who wants to take it. The attendance is usually made up of farmers or their sons instead of the farm owner, prospective buyers or salesmen. In a few cases the schools are under the auspices of the county agricultural bureau, an association or a tractor firm. The latest school was held at Waterloo on Jan. 17 and 18 and was conducted by the International Harvester Co., which prepared a textbook for the use of those taking the instruction and also furnished a tractor and other equipment for the school.

Part of the instruction was the answering of all questions that may have come to operators of tractors. In connection with this school there was shown at a local theater a film entitled "America's Golden Harvest," which showed a tractor in operation.

* * *

Industrial Hygiene Library

A library of industrial hygiene is being prepared by the Department of Labor. It is planned to collect all the information available which bears on questions of health in industry, industrial safety and employment management, and to have this information readily accessible at all times.

World's Industrial Forge

By E.C.Porter
News Editor

Melting Points of Chemical Elements

The table of melting points of chemical elements here given was issued by the Bureau of Standards, Department of Commerce, in answer to numerous requests for this information.

The values of the melting points used by the Bureau of Standards as standard temperatures for the calibration of thermometers and pyrometers are indicated in capitals. The other values have been assigned after a careful survey of all the available data.

Element.	C.	F.	Element.	C.	F.
Helium	<−271	<−456	Neodymium	840?	1544
Hydrogen	−259	−434	Arsenic	850	1562
Neon	−253?	−423	Barium	850	1562
Fluorine	−223	−369	Praseodymium	940	1724
Oxygen	−218	−360	Germanium	958	1756
Nitrogen	−210	−346	SILVER	960.5	1760.9
Argon	−188	−306	GOLD	1063.0	1945.5
Krypton	−169	−272	COPPER	1083.0	1981.4
Xenon	−140	−220	Manganese	1230	2246
Chlorine	−101.5	−150.7	Beryllium (Glucinum)	1280	2336
MERCURY	− 38.87	− 37.97	Samarium	1300-1400	2370-2550
Bromine	− 7.3	+ 18.9	Scandium	?	
Caesium	+ 26	79	Silicon	1420	2588
Gallium	30	86	NICKEL	1452	2646
Rubidium	38	100	Cobalt	1480	2696
Phosphorus	44	111	Yttrium	1460	2714
Potassium	62.3	144.1	IRON	1530	2783
Sodium	97.5	207.5	PALLADIUM	1549	2820
Iodine	113.5	236.3	Chromium	1615	2939
Sulphur	S_I 112.8 S_{II} 119.2 S_{III} 106.8	235.0 246.6 224.2	Zirconium	1700?	3090
Indium	155	311	Columbium (Niobium)	1700?	3020
Lithium	186	367	Thorium	>1700 <Mo.	>3090 <Mo.
Selenium	217-220	423-428	Vanadium	1729	3128
TIN	231.9	449.4	PLATINUM	1755	3191
Bismuth	271	520	Ytterbium	?	
Thallium	302	576	Titanium	1800	3272
CADMIUM	320.9	609.6	Uranium	<1850	>3360
LEAD	327.4	621.3	Rhodium	1950	3542
ZINC	419.4	786.9	Boron	2200-2500?	4000-4500
Tellurium	452	846	Iridium	2350?	4260
ANTIMONY	630.0	1166.0	Ruthenium	2450?	4440
Cerium	640	1184	Molybdenum	2550	4620
Magnesium	651	1204	Osmium	2700?	4890
ALUMINUM	658.7	1217.7	Tantalum	2900	5250
Radium	700	1292	TUNGSTEN	3400	6152
Calcium	810	1490	Carbon	>3600	>6500
Lanthanum	810?	1490			
Strontium	>Ca<Ba?				

MELTING POINTS OF THE CHEMICAL ELEMENTS

As nearly as may be, all values, in particular the standard points, have been reduced to a common scale, the thermodynamic scale. For high temperatures and for use only with optical pyrometers this scale is satisfied very exactly by taking $c_2 = 14{,}350$ in the formula for Wien's law (see Bureau of Standards Circular No. 7 or Scientific Paper No. 11) connecting I_λ, monochromatic luminous intensity of wave length λ, and T, absolute temperature: $I_\lambda = c_1 \lambda^{-5} e^{-\frac{c_2}{\lambda T}}$. For all purposes, except the most accurate investigations, the thermodynamic scale is identical with any of the gas scales.

At high temperatures some of the values are quite uncertain; thus while the melting point of platinum may be considered accurately known to 10 deg. C., that of tungsten is possibly uncertain by 50 deg. C. or more. Temperatures centigrade are rounded off, and the exact Fahrenheit equivalents are usually given.

* * *

Philadelphia Foundrymen Elect Officers

The Philadelphia Foundrymen's Association at its monthly meeting Jan. 8 reëlected the following officers for 1919: President, Thomas Devlin, Thomas Devlin Manufacturing Co.; vice president, George C. Davies, Pilling & Crane; treasurer, Josiah Thompson, J. Thompson & Co.; secretary, Howard Evans, J. W. Paxson Co.; executive committee, Walter Wood, R. D. Wood & Co.; Thomas M. Eynon, Eynon-Evans Manufacturing Co.; H. L. Haldeman, Pulaski Iron Co.; Walter T. MacDonald, Fletcher Works, Inc.; W. T. Dunning, Chester Steel Castings Co., Chester, Penn.

* * *

Copper Estimate

Official and semiofficial figures indicate that the world's supply of refined copper is about 300,000,000 lb. It is estimated that the allied countries of Europe will require the coming year between 950,000,000 and 1,000,000,000 lb. of American copper. If industrial readjustment in this country is accomplished within two or three months the domestic demand should absorb more than 1,000,000,000 lb. next year.

Railroad Administration Has Big Project in View

Will Spend as Soon as It Is Able the Huge Sum of Money at Its Disposal

Improvements authorized on the railroads under federal control to Dec. 31, 1918, required for their completion $573,150,159. Of this the Administration used $242,260,135. The latter figure provides for the payment for improvements to Nov. 30.

For equipment the Administration was authorized to spend $658,893,761, and by Nov. 30 had bought equipment valued at $254,060,941. For construction, extensions, etc., an expenditure of $46,771,078 was authorized, but of this sum only $20,194,318 was used.

The entire program provided for capital expenditures of $1,278,814,998, of which until Nov. 30 $516,515,394 had been disbursed. These figures are given in a report by former Director General McAdoo, just made public.

Under Direction of Lovett

The work of financing improvements, equipment and construction is under the direction of the Division of Capital Expenditures, administered until the end of last year by Judge Robert S. Lovett, former chairman of the board of directors of the Union Pacific.

For locomotives the Administration expended $91,451,107, and for freight train cars $130,000,000, while for passenger cars only $1,829,085 was disbursed. Nearly three hundred million dollars had been authorized for freight cars, and the Administration was prepared to spend approximately two hundred million dollars for locomotives.

After the armistice was signed the program was cut somewhat, but it is understood that the Administration intends to go forward with ambitious building projects as soon as it feels free to do so.

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German Workshops Use Paper Belts for Machinery

A driving-belt substitute made of paper is now being introduced into German workshops for driving machinery, according to reports. The paper is cut into narrow bands which are then spun. The belts are made by weaving or braiding. Woven-paper belts are of two kinds—paper-fabric belts and paper-thread belts, the former type being the most frequently used. The fabric is first cut into bands 40 m. long, which are subsequently made up according to the desired width and thickness. A core of strengthening material is interposed, either cot-

ton or sheet metal, though more recently these cores have consisted of paper thread and metal wires interwoven. The core is surrounded with the paper strips and the whole sewed with strong thread. Belts so prepared are said to be very flexible and to wear satisfactorily. Woven-paper belts have a tensile strength of from 100 to 125 kilos per centimeter of width.

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Kelly Reamer Company Sends Telegram to the Senate

The following is a telegram sent to the Senate by the Kelly Reamer Co., Cleveland, Ohio, asking for advice, also requesting information on the $1,500,000,000 being withheld from manufacturers and which is causing much inconvenience to the machine-tool industry:

Jan. 30th, 1919.

The United States Senate,
Washington, D. C.
(To the attention of the President of the Senate.)

Honorable Gentlemen: We think some employee has stolen a dollar. Our superintendent suggests holding up our entire payroll until his committee locates the culprit. I as general manager advise paying all hands, then find the guilty one, prosecute and recover the dollar. Will you kindly ask your honorable body to grant us a decision on this problem? We wish to be prudent, but if possible to avoid further stoppage of our industry. We await with interest your valued advice and more light.

Respectfully yours,
WILLIAM E. KELLY,
President The Kelly Reamer Company.

P. S.—As an ultimate beneficiary to some thousands out of the one and a half billion payroll now held in abeyance we feel a deep concern that enough receivers cannot be procured to supply all of the manufacturers who have exhausted their working capital in delivering the goods at any cost. We, as one of the many manufacturers, seriously and urgently implore your honorable body to establish a precedent, lay aside all red-tape customs and pay off all hands, starting the wheels of industry now dormant and give employment to two million returned soldiers. The Government is big enough to find, prosecute and convict, if fraud is discovered. This is a calamity, an emergency calling for quick action. We want your prompt and best efforts in this crisis.—Kelly.

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Sawmill Machinery in Russia

An American band-saw manufacturer urges the possibility of selling band-sawing machinery in Russia to the displacement of the frame saws now generally used in that country.

There is no doubt of the advantage of the American band-saw mill in output, but the frame saw, which can be operated by comparatively unskilled labor, is already a standard type in Russian sawmills. Band saws can be sold there only where foreign superintendents can be had to train the workmen. Undoubtedly sawmills will be installed by foreign capital and managed by Americans who are capable of getting results out of band-saw mill machinery, but the bulk of the business will likely be supplied by frame saws of the Swedish type should American manufacturers undertake to compete for the Russian market by supplying frame saws of the type generally used in Russia. In this way a share of the present business probably could be secured.

Personals

WILLIAM J. PURDY, formerly with the Hoe Printing Press Co., has been made assistant manager of the Wood Printing Machine Co., Plainfield, N. J.

THOMAS W. PANGBORN, president of the Pangborn Corporation, Hagerstown, Md., has been elected a director of the Maryland Surety and Trust Co. of the same city.

ALONZO WHITCOMB, who for four years has had charge of the engineering department of the Heald Machine Co., Worcester, Mass., is now shop superintendent.

J. ARTHUR DEAKIN, formerly American representative of H. W. Ward & Co., Ltd., Birmingham, England, has become New York manager of E. Isbecque & Co., 15 Park Row, New York.

E. R. ABBOTT has been discharged as captain from the Chemical Warfare Service of the United States Army and is now sales manager of the Kar Engineering Co., Inc., 79 East 140th St., New York.

S. R. WARNER, formerly in charge of gage production in the Plant Section of the New York District Ordnance office, is now connected with the sales department of Russell, Holbrook & Henderson, Inc., New York.

LEWIS RUSSELL, who has been manager of the plant section of the New York District Ordnance office, has returned to his duties as president of Russell, Holbrook & Henderson, Inc., 30 Church St., New York.

E. ERICKSEN, formerly manager of the Allied Machinery Co. in Russia, has become associated with the Youroveta Home and Foreign Trade Co., Inc., of which A. Peskine is manager of the machine-tool department.

MAJ. MASON P. RUMNEY will be out of the service about Feb. 15 and will return to the Detroit Steel Products Co. as assistant general manager. He has been located in Washington with the Ordnance Department.

L. P. PROSSEN, who was mechanical superintendent of the Black and White Taxicab Co., New York, has been made vice president of the Nilson-Miller Co., Hoboken, N. J. He will be in charge of the gear-cutting, piston and piston-ring departments.

L. M. BAKER has been made special sales engineer of the Hyatt Roller Bearing Co., Detroit. At one time he was sales manager of the United Motors Service, Inc., and previous to that was Western sales manager of the Standard Steel Spring Co., Detroit.

K. K. HOAGG has been appointed engineer in the sales department of the Hyatt Roller Bearing Co., Detroit. Mr. Hoagg, who has been connected with the company since 1912, left his position as assistant chief engineer to go into Government service.

WILLIAM B. PATTERSON, president of the Patterson Tool and Supply Co., Dayton, Ohio, has been appointed special representative in Italy and Switzerland of the Monarch Machine Tool Co., Sidney, Ohio. He will, however, retain his position and interests in the corporation of which he is president.

ROBERT S. ALTER, vice president and foreign manager of the American Tool Works, Cincinnati, and president of the Foreign Trade Association of the Chamber of Commerce, has been elected to the board of directors of the Mississippi Valley Foreign Trade Association, an organization which was launched recently at New Orleans, and which brought together practically all the live wires of the export trade in the Middle West.

L. S. DEVOS has recently been appointed general manager of the machinery department of the American Machinery Syndicate, 35 West 39th St., New York. From October, 1917, to the latter part of December, 1918, Mr. Devos was the Chief of the Inspection Department of the United States Air Service, with offices in Paris. Previous to his entry into the United States Army, he was the New York representative of the Selson Engineering Co., Ltd., London.

Obituary

THOMAS F. HART, widely known as a manufacturer of shoemaking machinery, died on Jan. 22, 1919, at his home, in Lynn, Mass.

ELMER L. EWING, secretary and acting treasurer of the Sharples Separator Co., died of pneumonia at his home in West Chester, Penn., on Jan. 29, 1919.

WILLIAM J. SELLERS BANCROFT, a noted inventor, and founder of the firm of Bancroft & Sellers, died Jan. 29, 1919, at his home, in Philadelphia, Penn. He was 76 years old.

Trade Catalogs

Steelcrete Machine Guards. Expanded Metal Engineering Co., 8 West 40th St., New York. Booklet. Pp. 40; 3¼ x 6¼ in. This booklet describes Steelcrete mesh, giving sizes and various uses, also Steelcrete machine guards and partitions with their specifications.

Ladew Leather Belting. Edward R. Ladew Co., Inc., Glen Cove, N. Y. Catalog. Pp. 104; 6 x 9 in. The first part of this book gives a discussion of belt engineering and belting economics. Following this are several fully illustrated pages describing just how Ladew belts are made. Price lists and specification tables are also given.

The Design and Test of Standards of Mass. Bureau of Standards, Washington, D. C. Circular No. 3. Pp. 90; 7 x 10 in. This circular treats of the types of weights used as standards of mass and of their design, test and adjustment. Information is given relating to the manner of using weights, and complete routine for their verification, test and intercomparison is developed. Those interested may obtain a copy by addressing a request to the Bureau of Standards, Department of Commerce, Washington, D. C.